SYLLABUS

OF

LECTURES ON PHYSIOLOGY.

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NOTICE.

THE following Syllabus of Lectures on Physiology is intended for the use of Students. In printing it, the Author's object has been to exhibit a systematic enumeration of the subjects treated of in Physiological Works and Courses of Lectures, and at the same time to present a view of the method followed by him in the exposition of these subjects in his Lectures. In some of the departments, he has found it necessary, for the sake of clearness and utility, to extend the details of facts beyond the limits usually assigned to a Syllabus.

INTRODUCTION.

NATURE AND OBJECT OF PHYSIOLOGY: MANNER IN WHICH IT OUGHT TO BE STUDIED: KNOWLEDGE REQUIRED PREVIOUSLY TO COMMENCING ITS STUDY: USE OF THE COLLATERAL SCIENCES IN ITS INVESTIGATION: AND IMPORTANCE OF A KNOWLEDGE OF PHYSIOLOGY IN THE STUDY OF OTHER DEPARTMENTS OF MEDICINE.

Part I.

NATURE OF LIVING BEINGS, AND LIFE IN GENERAL; VITAL AND ANIMAL PROPERTIES; ARRANGEMENT OF THE FUNCTIONS, &c.

§ 1. Comparison of the Properties of Organized and Inorganized, or Living and Mineral Bodies.

The Living, or organized body, as the plant or animal, is necessarily compound, has a heterogeneous structure termed Organization, its parts are mutually dependent on one another; it consists of textures or organs which perform certain offices, functions, or vital operations, all concurring to maintain life: certain changes are necessary to its existence; it converts foreign matter into its own substance by assimilation; originates by generation from a being like itself; has the power of reproduction, or of giving rise to others of the same kind; passes from youth to age, decays, and dies.

The mineral, lifeless, or inorganized body, may be either simple or compound, solid, fluid, or gaseous: has no mutual dependence of parts, no finite period of duration, and exists without necessary change.

The living functions or operations collectively constitute the state we denominate Life: Definition of Life: Vitality: Vital properties.

§ 2. Comparison of the Structure and Vital operations of Plants and Animals, in the more perfect members of the two classes.

Plants are fixed to the soil; absorb nourishment by external pores or by roots: this nourishment is fluid: they consist of ligneous fibre and cellular texture chiefly, and nitrogen is not always an ingredient in them.

Animals have the powers of sensation and voluntary motion; take food into their interior voluntarily: this food may be solid or fluid; it is changed or digested in their internal cavity, from which it is afterwards absorbed into their system: they consist of cellular, muscular, and nervous textures principally: nitrogen is an essential ingredient in them.

Bodies in which the distinctive characters are not very apparent, and in this respect holding an intermediate place between Plants and Animals, Confervæ, Sponges, &c.

Sensation and Voluntary Motion essential to Animals, and not possessed by Plants: Phenomena in Plants erroneously attributed to these powers.

§ 3. General View of the Animal Properties of Sensibility and Contractility.

Properties of the Nerves and Nervous System; Sensory, Motory, and Sympathetic Nerves. Sensation, general and special. Other properties of Nerves, or the Nervous System.

Muscles, voluntary and involuntary: phenomena of muscular contraction.

§ 4. Arrangement of the Functions of Animals, and of the Human Body.

Galen's division of the functions into Vital, Natural, and Animal: subsequent changes on this classification. Bichat's division of them into Organic and Animal. Cuvier's division into Nutritive, Reproductive, and Animal.

Relation of the different functions to one another. Importance of a good arrangement in facilitating the study of physiology: principles on which it ought to be founded.

Explanation of the arrangement to be pursued in this Course.

§ 5. Literature of Physiology.

Works on General Physiology. Works on Human Physiology.

[*The following Table exhibits the arrangement pursued in treating of the separate Functions.*]

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§ 2. Mastication of food.
§ 3. Mixture of food with Saliva.
§ 4. Swallowing of food.
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DIV. I.—NUTRITIVE FUNCTIONS.

FUNCTIONS OF ASSIMILATION OR NUTRITION: ALIMENTARY FUNCTIONS: THOSE SUBSERVIENT TO THE PRESERVATION OF THE INDIVIDUAL. GENERAL OBSERVATIONS ON THE NATURE OF THIS CLASS OF FUNCTIONS AND ARRANGEMENT OF THE PROCESSES COMPREHENDED UNDER IT.

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The changes which Food undergoes in the Alimentary Canal, from its introduction into the mouth till the absorption of its digested parts by the Lacteal Vessels.

§ 1. Food, its nature and kinds, and the mode of its introduction into the mouth.

Food consists of organized matter, dead or alive: instances in which mineral substances have been supposed to nourish man or animals: clay-eaters.

Vegetable and Animal Food; differences in the structure and habits of animals according as they are herbivorous, carnivorous, or omnivorous: Food of man.

Vegetable food; its nutritive principles, starch or farina, gluten, sugar, gum, mucus, jelly, lignin.

Animal food; its nutritive principles, albumen, gelatine, fibrine, osmazome, caseum, oils, fat, &c.

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Condiments.

Comparative digestibility and nutritive powers of the different elementary or proximate principles of aliment, and of different kinds of food.

Supposed necessity of the presence of nitrogen in the food of animals; experiments of Magendie, Londe, Leuret, and Lassaigne, on this subject.

Quantity of food necessary for Man. Periods of feeding in Man and Animals.

Hunger and Thirst; their nature, seat, and causes. Length of time that Man and Animals can support the want of food: effects of partial and complete starvation.

Introduction of food, solid or fluid, into the mouth: different provisions in animals for this. Suction, of two kinds.

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1. Motion of the Jaws and Tongue in Mastication.

Structure of the jaws, and the muscles attached to them, in Carnivorous and Herbivorous Animals: in Man.

2. Structure and Uses of the Teeth.

Number, position, form, structure, and chemical composition, of the Permanent Teeth. Varieties in animals in the disposition of the enamel, bone and crusta petrosa. Sensibility and Vascularity of Teeth.

Temporary teeth in children and young animals: their first appearance and growth.

Diseases of the Teeth. Caries, Exostosis, &c.

Structure and disposition of the teeth in Animals; in Quadrumana, Carnivora, Insectivora, Rodentia, Edentata, Pachydermata, Ruminantia, Cetacea, Reptiles, Fishes, &c.

§ 3. INSALIVATION. Mixture of the Food with Saliva and other fluids in the mouth.

Glandular organs secreting the saliva. Secretion of the saliva; its conveyance to the mouth; quantity of this fluid secreted in a given time.

Composition of the saliva, and its chemical and physical properties.

Action of the saliva on the food.

Diseased conditions of the saliva; salivary concretions; tartar of the teeth, &c.

§ 4. DEGLUTITION or Swallowing: the passage of the Food from the Mouth to the Stomach.

Structure of the Fauces, Pharynx, and Gullet.

Mechanism of Deglutition: voluntary and involuntary parts of the process; motions of the tongue and fauces; motions of the pharynx and œsophagus; difference in the duration of the muscular contractions at the upper and lower part of the œsophagus.

Closure and opening of the glottis during swallowing. Uses of the epiglottis in this process. Experiments of Magendie, Reichel, Mende, and others.

§ 5. CHYMIFICATION. Formation of Chyme by the solution or digestion of the Food in the Stomach.

1. Structure and Functions of the Stomach.

Structure of the stomach in Man: its variations in Animals, according to their habits.

State of the stomach in fasting: change of form and position which it undergoes in filling.

Peristaltic action of the stomach; action of the cardiac and pyloric orifices of the stomach as valves: central or hour-glass constriction of the stomach: Sir E. Home's observations.

Secretions from the mucous membrane lining the stomach. The gastric-juice; its sources, properties, and chemical composition; its quantity in different circumstances; manner of procuring it for observation in Man or Animals.

2. Action of the Gastric-Juice upon Food.

Action of the gastric-juice on food out of the body, or artificial digestion: experiments illustrating this.

Change of the food within the stomach from the action of the gastric-juice. Different modes of investigating this: experiments of Reaumur with the Buzzard; of Dr Stevens with the Stone-eater; of Spallanzani on himself and on animals; of J. Hunter, Montègre, Wilson Philip, Tiedemann and Gmelin, Leuret and Lassaigne, Beaumont, Magendie, Sir A. Cooper, Stark, Gosse, and others.

Action of the gastric-juice on particular kinds of food: conclusions respecting the relative digestibility of different aliments.

Effect of different modes of cookery on food, of condiments, sauces, &c.

Pathological remarks on this function; causes of indigestion.

3. Theory of Digestion.

Properties and analysis of chyme, or the substance formed by the action of the gastric-juice.

Analysis of the gases evolved in the stomach during digestion; their source.

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Review of the principal theories of digestion in the stomach; putrefaction; coction; trituration; fermentation; theory of the vitalists, &c.

4. Emptying of the Stomach.

Mode in which substances more or less digested pass out of the stomach downwards; action of the pylorus.

Escape of air from the stomach upwards: eructation.

Escape of solids or fluids from the stomach by the gullet without effort; Regurgitation. Rumination of some animals: rumination in man.

Vomiting or violent discharge of the contents of the stomach upwards; phenomena preceding vomiting; nausea; causes of vomiting, action of emetics; muscular action by which the stomach is emptied in vomiting; action of the stomach itself, of the diaphragm, and of the abdominal muscles.

§ 6. CHYLIFICATION. Formation of Chyle by the further Solution or Digestion of the Food in the Intestines.

1. Structure and Functions of the Small Intestine.

Structure of the Small Intestine; its serous coat; muscular fibres; mucous membrane lining it; its villi; follicular glands or crypts, of Peyer and Brunner.

State of the small intestine in fasting animals; change it undergoes on being filled with food; its peristaltic action and propulsion of the food by it.

2. Change which the Food undergoes in the Small Intestine.

Mixture of the chyme with the fluids contained in the small intestine, and phenomena of the conversion of chyme into chyle, consequent on this mixture.

Farther changes on the food as it passes down the intestine.

Digestion of food which has passed through the stomach unchanged in the intestine.

3. Sources, Chemical composition, and properties of the Fluids mixed with the Food in the Small Intestine.

Mucus of the intestine: watery fluid secreted over the whole mucous surface: fluid secreted in the glandular follicles.

Pancreatic fluid: structure of the pancreas; quantity of fluid secreted by it; mode in which it is poured into the intestine; mode of procuring this fluid for observation: chemical composition of the pancreatic fluid; its differences from saliva.

Bile: structure of the liver, gall-bladder, and excretory ducts: secretion of the bile; circumstances influencing the quantity of bile formed or the rapidity of its excretion, such as presence of food in the intestine, irritation of the coats of the intestine or biliary ducts. Question as to whether the bile is separated principally from venous or arterial blood; observations of Abernethy and Simon. Chemical composition and properties of the bile of man and animals.

Gases evolved in the small intestine.

4. Theory of the conversion of Animal and Vegetable Food into Chyle.

Review of the action of the mucus, pancreatic fluid, and bile on the chyme and food: nature of the change which they undergo from this action: formation of chyle within the intestine: Is the matter thus formed the same as that which is absorbed?

Effects produced on digestion by tying the excretory ducts of the pancreas or liver. Experiments of Brodie, Magendie, Prout, Mayo, Tiedemann and Gmelin, Leuret and Lassaigne; regeneration of these ducts.

5. Structure and Functions of the Large Intestine.

Structure of the colon, cœcum, rectum.

Composition and properties of the fluids secreted by the large intestine.

Farther changes effected on the food during its passage through the large intestine; digestion in the cœcum.

Gases evolved in the large intestine.

Defecation.

§ 7. General Review of the DIGESTIVE FUNCTIONS in the Lower Animals.

Introductory remarks.

1. Digestive Organs and Functions in the avertebrated Animals.

Digestion in the simplest kinds of animals in which the alimentary cavity has only one opening; Infusoria with simple and compound stomachs; Polypi and Coralline animals; Star Fish and Actinia; food of these animals.

Digestion in animals of a simple structure having an intestinal canal, mouth, and anus; other apparatus connected with the alimentary canal in such animals; organs of prehension, biliary and salivary organs: Digestion in the Articulata and Mollusca; connection of the digestive function in these animals with the more or less complicated structure of the circulatory and respiratory organs.

2. Digestion in Vertebrated Animals.

General structure of the digestive organs in the Vertebrata; addition of the pancreas.

Digestion in Fishes; stomach; muscular stomach approaching to a gizzard in some. Intestines. Pancreatic appendages of the duodenum. Spiral valve in the rectum of cartilaginous fishes.

Digestion in Reptiles. Simple state of the stomach and intestine in these animals. Peculiar structure of the œsophagus of the Turtle. Change that takes place in the structure of the digestive organs in some Batrachia during their metamorphosis corresponding with their change of food. Power of many of these animals to subsist for a long period without food.

Digestion in Birds: structure of the digestive organs; the tongue, œsophagus, crop or ingluvies, glandular stomach or proventriculus. Muscular stomachs or gizzards of birds; membranous stomachs; intermediate forms. Experiments on the digestion of food by birds. Glands of the stomach; their differences in herbivorous, granivorous, and carnivorous birds.

Digestion in Mammiferous Animals: simple and compound stomachs: Omnivorous animals: Carnivora, Insectivora, Rodentia, Ruminantia, Cetacea: rumination in animals with compound and in those with simple stomachs: intestines of different animals: differences in their structure and relative length according to the habits of the animals. Accessory organs.

CHAP. II. SANGUIFICATION,

The Changes by which the Digested parts of the Food or Chyle, when absorbed from the Intestine, and the Lymph absorbed from all parts of the Body, are converted into Blood.

§ 8. Absorption, Motion, and Course of the CHYLE.

1. Structure and Distribution of the Lacteal Vessels.

Discovered by Aselli in 1622, in animals; the observation of them in Man; labours of Wesling, Pecquet, Bartholin, Rudbeck, Ruysch, Hewson, Cruikshank, Mascagni.

Origin of the lacteals from the mucous membrane of the intestine; from the villi. Views of Lieberkühn, Cruikshank, Prochaska, Rudolphi, and Hedwig, respecting this.

The lacteals have not frequent communications with the veins, as has been supposed by some; observations of Panizza.

Structure of the mesenteric glands: their vasa inferentia and efferentia; these glands not cellular, but formed by ramifications of the lacteal vessels.

2. Absorption of the Chyle by the Lacteal Vessels.

Very little known respecting the nature of this process; turgidity of the mucous membrane during absorption. Various opinions that have been advanced respecting the causes of the absorption: Action of the villi; Endosmosis or organic transudation; capillary attraction; comparison of the villi with the spongioles of the roots of plants. Have the villi a power of selection? or does the chyle undergo any change in the act of being absorbed?

Do the lacteal vessels absorb other substances besides chyle? Experiments of various physiologists respecting this.

3. Flow of the Chyle in the Lacteal Vessels and Thoracic Duct.

Phenomena of the motion of the chyle in the lacteals; effect of ligature of the lacteals; valvular structure; contractility of the lacteals; experiments of Schreger, Haller, Tiedemann, and Gmelin, in proof of it.

Velocity of the flow of chyle in different parts of its course; quantity which may be procured in animals in a given time; causes tending to vary it; its continuing to flow after death.

Flow of chyle in the thoracic duct; obvious contractility of this tube; effects of ligature or pressure on the thoracic duct in producing rupture of this vessel: experiments of Sir A. Cooper, Duverney, Flandrin, Magendie, and Dupuytren, on this; varieties in the structure and course of the thoracic duct.

§ 9. Absorption, Motion, and Course of the LYMPH.

1. Structure and Distribution of the Lymphatic Vessels.

Discovery of the lymphatic vessels: their valves; their coats.

Opinions respecting the origin of the lymphatics; 1. That they are prolongations of the extremities of small bloodvessels; 2. That they begin in all parts of the body by open mouths; 3. That they begin by shut extremities; or, 4. That they arise from cellular dilatations of their extremities.

Have the lymphatics frequent communications with the veins, or only through the great lymphatic trunks? Observations of Mascagni, Fohmann, Lauth, Lippi, Panizza and others respecting this.

Junction of the lymphatics with the lacteals, and origin of the thoracic duct.

Structure of the lymphatic glands.

2. Absorption of Lymph, and its flow towards the Veins.

Proofs that absorption of the organized parts of the body is constantly going on; effects of this: names given to this kind of absorption; probable causes of the absorption of lymph.

Flow of the lymph; causes of its motion; quantity of lymph procured from animals; estimate of the whole quantity mixed with the chyle in the thoracic duct.

§ 10. Absorption of Chyle, Lymph, and other substances, by the Veins.

Experiments shewing that some substances are absorbed by the mesenteric veins.

Experiments in proof of absorption of some matters by the pulmonary veins.

Experiments on the veins of the body and limbs; Magendie's; these not satisfactory.

Experiments shewing the transudation of some substances through the coats of the veins, unsatisfactory.

§ 11. CHANGE of CHYLE and LYMPH into BLOOD.

1. Properties and Chemical Composition of the Chyle.

Analysis of chyle, 1. In the intestine before it enters the lacteal vessels. 2. In the lacteal vessels before it passes the mesenteric glands. 3. After it has passed through them: globules in the chyle; fibrine in it; coagulation of the chyle after being taken from the body.

Differences observable in chyle according as it is formed from animal or from vegetable food; other circumstances modifying its qualities; fat or oil in it.

2. Properties and Chemical Composition of Lymph.

Mode of procuring the lymph for analysis: analysis of lymph from the human body; from animals: globules of the lymph.

Lymphatic vessels and lymph of the spleen; remarks on the supposed Function of the Spleen as an assistant in Sanguification.

3. Properties and Chemical Composition of the Fluid of the Thoracic Duct formed by the mixture of Chyle and Lymph.

General review of the successive changes in the composition of the chyle; addition of new proximate principles to it; its conversion into blood; this perfected by respiration, and by the action of the liver.

Theory of Sanguification. Observations of Prout, Tiedemann, Gmelin and others.

§ 12. PROPERTIES of the BLOOD.

1. Physical Properties of the Blood.

Nature and appearance of the blood as it is seen circulating in the living body; its fluid part; the globules floating in it.

Specific gravity of the blood; its temperature within the body; circumstances modifying this.

Fluid of the blood, or liquor sanguinis, in which the colouring particles float; J. Müller's experiments.

Globules of the blood or colouring particles; their size, figure, and structure; varieties in these respects in animals; larger size in young animals and in cold-blooded animals: Smaller lymph or chyle globules in the blood; mode of separating them from the larger ones: Theory of the formation of the red globules of the blood by the spleen, liver, &c.; observations of Hewson. Error of Prevost, Dumas, and Sir E. Home, regarding their nature; observations and experiments of J. Müller.

2. Changes which occur in Blood after it has been drawn from the Living Body.

Coagulation of the blood; phenomena of this process; circumstances modifying it; 1. Exposure to air; 2. Rest; and, 3. Cooling: Is heat evolved during the coagulation? Experiments of Gordon and J. Davy. Causes of the coagulation unknown; theory of the vitality of the blood considered.

Separation of coagulated blood into the clot and serum: serum; its nature; mode of procuring: the clot consists usually of the fibrinous part of the blood and red globules: the fibrine dissolved in the serum of the blood while in the living body; mode of separating fibrine from the clot; mode of shewing the colouring particles and fibrine separately: Dr Babington's experiments of passing the blood through oil: spontaneous separation of the liquor sanguinis and colouring particles occurring in the horse's blood; Müller's experiment of the filtration of the liquor sanguinis of the frog's blood: Buffy coat formed on the surface of the blood in inflammation and other circumstances; phenomena of its formation; circumstances influencing its appearance, quantity, firmness, &c.; observations and theory of Schrœder Van der Kolk.

3. Chemical Composition of the Blood.

Analysis of the fibrinous part.

Analysis of the colouring matter; presence of iron in it: Engelhart's experiments: hematosine or peculiar animal principle giving colour to the blood; properties of this substance.

Analysis of the serum; specific gravity of serum; salts; oil in the serum.

Analysis of the blood in different circumstances; at different ages; in different animals. Comparative analysis of venous and arterial blood. Experiments of Lecanu, Denis, Michaelis and others.

CHAP. III. CIRCULATION,

The Passage of the Blood through the Heart, Arteries, Capillaries, and Veins.

Introductory view of the function of Circulation in animals generally; comparison of this function in plants and animals; simpler forms of the circulatory organs in the lower animals.

General view of the function of circulation in Man; its uses: the course of the blood in Man.

Discovery of the Circulation of the Blood by Harvey in 1619.

Proofs of the correctness of the Harveian view of the circulation derived from experiments and observations on man and animals.

§ 13. Flow of Blood through the HEART. Structure and Functions of this Organ.

1. Structure of the Heart.

Its position, shape, and connections; cavities, auricles and ventricles; openings into them; disposition of the muscular fibres of the auricles and ventricles; pericardium; bloodvessels, nerves, and lymphatics; structure of the valves; action of the valves; different opinions regarding this.

2. Phenomena of the Heart's Action.

Alternate contraction and dilatation of the cavities of the heart, as seen in a living animal; order of succession in the contraction of auricles and ventricles; change of form and position of the heart during contraction.

Pulsation of the heart against the parietes of the chest; cause of this; various opinions respecting it; William Hunter's view. Sounds produced by the action of the heart; attempts to explain their cause; views of Läennec, Turner, Williams, Despine, Corrigan, Hart, Stokes, and Hope.

Dilatation of the heart, a passive motion.

Number of pulsations in a given time. Variations.

Pathological remarks on the action of the heart.

3. Stimulus exciting the Heart to Contraction.

Does the blood stimulate the auricle and ventricle to act? Do the venous and the arterial blood act as different kinds of stimulus to the cavities of the heart?

Dependence of the heart's action on the brain or nerves; the heart an involuntary muscle: influence of mental emotions on the action of the heart: effect of division of the nerves of the heart: attempts to stimulate the heart by galvanism through its nerves; effects of sudden and violent injuries of the brain or spinal marrow on the heart's action.

Continuation of the heart's action after the apparent death of animals; mode of resuscitating the heart's action when suspended, in asphyxia, &c.

4. Passage of the Blood through the Cavities of the Heart.

Estimate of the quantity of blood which passes out of the ventricles at each stroke of the heart, and calculations founded on this of the velocity of the circulation of the blood.

Relative capacities of the cavities on the two sides of the heart; circumstances affecting this; cause of the greater capacity of the right auricle and ventricle frequently found after death.

Regurgitation of the blood from one cavity of the heart into another, and from the auricles into the veins; venous pulse; morbid increase of this.

§ 14. Motion of the Blood in the ARTERIES.

1. Structure and Properties of the Arteries.

Their coats; the properties of these; irritability of the middle or fibrous coat; experiments of Verschuir and others in proof of this; tonic power of the arteries; differences between tonicity and irritability; experiments of Parry and Poiseuille; bloodvessels and nerves of the arteries.

Distinct muscularity of the arteries in some animals.

2. Influence of the Arteries on the Flow of Blood through them.

Momentary dilatation of the arterial system at each systole of the ventricle. Experiments of Parry and others to investigate the degree of this dilatation; elongation and motion of the arteries produced by the impulse received from the left ventricle of the heart.

Arterial pulse; propagation of the impulse of the left ventricle of the heart along the column of blood in the arteries; how this is affected by the elasticity or vital properties of the arteries; Parry's opinion; circumstances causing a variation in its strength, fulness, frequency, &c.

Effects of the action of the arteries on the flow of the blood through them: the conversion, 1st, of an intermitting, and, 2d, of a remitting, force into a constant one by their elasticity; corresponding change in the stream of blood: diminution of the velocity of the blood as it proceeds from the larger to the smaller arteries; 1st, on account of the area of the whole arterial system being enlarged; 2d, from the subdivision and alteration in the direction of the arteries: estimate of the effect of friction in retarding the flow of blood: application of the law of equal diffusion of pressure by fluids to the blood in the arteries, and illustrations of its effects in Aneurismal tumors, &c.

Review of the nature of the reaction of the arteries on the blood driven into them by the heart. Do the arteries contribute to propel the blood by giving any additional force? Examples of alleged independent action of the arterial tubes.

Experiments made with a view to estimate the force of the blood in different arteries; 1st, by Hales, by the height to which the blood rises from divided arteries: 2d, by Poiseuille, by the height to which mercury is supported in a tube connected with a divided artery, as in the hæmodynamometer; calculations of the force of the heart, and of the impetus of the blood founded on these and other data.

§ 19. Motion of the Blood in the CAPILLARY VESSELS.

1. Structure and Properties of the Capillary vessels.

Have the Capillaries any distinct coats or not? difficulty of making any distinction between the smaller arteries or veins and the capillary vessels; definition of capillary vessels. Exhalant vessels; termination of arteries in serous vessels, excretory ducts of glands, &c. Erectile textures.

The irritability of the capillaries obvious; mode of shewing it in transparent parts of cold blooded animals, in the mesentery of warm-blooded animals, &c.

2. Phenomena of the Capillary Circulation, and Influence of the Capillary Vessels on the flow of Bood.

Phenomena of the circulation of the blood in different organs and textures of the body; observations of Malpighi, Haller, and other physiologists on this subject; appearance of the red globules passing through these vessels; do the globules ever take a course in the parenchyma out of the vessels?

Modification of the flow of blood by the action of the capillary vessels; the stream of blood in general rendered quite uniform by them; is the impulse of the heart sufficient to carry the blood through the capillary vessels? or do they add any new impelling power?

Theories of the capillary circulation:—1. supposed spontaneous motion of the blood; 2. electrical theory; 3. other powers, endosmosis, &c.

Examples of the influence of the capillaries on the circulation of the blood independently of the action of the heart or arteries; alleged continuance of the circulation of blood through the capillaries after the heart has been removed, or the aorta tied; experiments of Haller, M. Hall, and others.

Circulation through the capillary vessels on the surface of the air-cells of the lungs; stagnation of imperfectly arterialized blood in them.

State of the capillary vessels in inflammation; observations of W. Philip, J. Thomson, Hastings, Kaltenbrunner, Gendrin, and others. Theories of inflammation; that of Allen: artificial production of inflammation; difference between active and passive inflammation. Congestion.

§ 20. Flow of Blood in the VEINS.

1. Structure and Properties of the Veins.

Their coats; elasticity of these; the valves; subdivision of veins; the smaller veins probably irritable; muscular fibres surrounding the vena cava near the heart. The veins distinctly muscular in some animals.

2. Phenomena of the Venous Circulation, and Action of the Veins on the flow of Blood.

Effect of ligature or obstructions of veins; the effect of gravitation and of the contraction of the surrounding muscles on the flow of blood in the veins.

Observations on the height to which the blood rises in tubes inserted into veins, by Hales, Ellerly, Davies, Serle, &c.

Velocity of the flow of blood in the veins; how modified.

Is the impulse from the heart sufficient to propel the blood through all the venous system, and back into the heart? Is the blood propelled through the veins by atmospheric pressure; Dr Carson's opinion that this is occasioned by the tendency which the lungs have continually to collapse; Sir D. Barry's opinion that it arises from the lungs not being immediately and completely filled during inspiration: Influence of these powers probably overrated; objections of Dr Arnott's and others to the above mentioned theories.

§ 21. GENERAL REVIEW of the Function of CIRCULATION, in reference to the Powers which move the Blood.

CHAP. IV. RESPIRATION,

The Changes which the Blood undergoes in its passage through the Vessels of the Lungs, and other processes connected with these changes.

Introductory View of the Nature of Respiration; its uses in the economy; its place in an arrangement of the functions, and the subordinate processes of which it consists.

§ 22. MECHANISM of RESPIRATION.

1. Introduction of Air into the Lungs, and its subsequent expulsion from them. Inspiration and Expiration.

Structure of the chest fitting it for undergoing an alternate enlargement and diminution of capacity; spine, ribs, cartilages, sternum, muscles, pleuræ, and lungs.

Inspiration or entrance of air into the lungs; its passage by the mouth or nose into the windpipe; mechanism by which the glottis is opened and shut; enlargement of the chest, how caused by the action of the diaphragm and intercostal muscles; opinions of Mayow, Borelli, and Haller; influence of the accessory muscles of inspiration; the expansion of the lungs, how produced.

Expiration. Powers by which natural and easy expiration is effected; elastic reaction of the parietes of the chest and action of the muscles of expiration; elastic reaction of the lungs themselves; supposed self-moving power of the lungs; experiments rendering its existence improbable. Forced expiration.

Frequency of respiration, and circumstances varying it: length of time that a person can hold his breath; observations on animals; histories of divers.

Motions of respiration semi-voluntary; influence of the uneasy sensation, produced by the existence of vitiated air in the lungs in exciting respiratory motions; other stimuli which produce these motions.

2. Modifications of Inspiration and Expiration.

Effort, or forcible attempt at expiration when the glottis is closed; its various kinds, according to the muscular exertion which accompanies it; expulsions; muscular exertions of the trunk and limbs, &c.

Coughing, sneezing, hiccup, laughing, yawning, sighing, sucking, stertorous breathing, dyspnœa, &c.

Wounds of the chest and lungs; difference in the impediment occasioned to respiration by a wound of the pleura only and by one of the lungs.

3. Sounds produced by the passage of air through the cells of the lungs, the bronchi and trachea, in breathing and speaking.

Natural sounds of respiration, and of the voice heard in different regions of the chest and neck. Alteration of these sounds by disease, and indications they afford of the presence of disease; auscultation; the stethoscope.

4. Capacity of the Lungs.

Estimates of the quantity of air inhaled into the lungs in an ordinary respiration, very various; quantity inhaled in a forced inspiration; quantity that can be expired forcibly from the lungs. Estimates of the whole capacity of the chest; experiments of Jurine, Goodwyn, Menzies, Allen and Pepys, Sir H. Davy, Fyfe, &c.; apparatus employed for that purpose.

§ 23. CHEMICAL CHANGES of the Air and Blood occurring during RESPIRATION.

1. Changes which take place in the Composition of the Atmospheric Air and of Blood, when in contact, out of the body.

Disappearance of the oxygen of the air in this process, and substitution of carbonic acid in its place; source of the carbonic acid, and its proportion to the oxygen consumed; experiments of Christison and others.

Change of colour which occurs in the blood; circumstances in which this change of colour takes place; effect of various substances, of salts, and of fluids containing salts, in producing it. Action of the air on the blood through certain substances, as animal membranes, certain fluids, &c.; experiments of Priestley, Ellis, Williams, &c.; theory of the change of colour; Dr Stevens' experiments and theory.

2. Change effected on the Air by the Respiration of Animals.

Resemblance of the phenomena to those that occur when air and blood act upon one another out of the body. Quantity of oxygen consumed in air once or oftener breathed; estimates of various experimenters regarding it. Is the quantity of carbonic acid formed in respiration equal to the oxygen consumed?

Circumstances affecting the quantity of carbonic acid evolved in respiration: exercise; kind of diet; drinks, alcoholic liquors, tea; sleep; time of day; season of the year: experiments of Fyfe and Prout.

3. Changes effected on the Blood by Respiration.

Differences between arterial and venous blood; their comparative ultimate analysis; greater quantity of carbon in venous blood; change of its colour; nature and uses of the change; the supposed completion of the conversion of chyle into blood by respiration.

4. Theory of the Chemical Changes occurring in Respiration.

Older chemical theories of respiration, in which this process is considered analogous to combustion, and the combination of carbon and oxygen is supposed to take place in the cells of the lungs: of Mayow, Priestley, Crawford, Black, Lavoisier, and Sir H. Davy. More modern theories; theory of Lagrange, Hassenfratz and Edwards, in which the carbonic acid is supposed to be formed in the capillaries of the systemic circulation, and to be brought ready formed in the venous blood to the lungs.

How is the carbonic acid or carbon separated from the venous blood in the lungs; Ellis' theory of secretion.

Edwards' experiments, shewing that some oxygen may be absorbed by the lungs of animals, without a corresponding evolution of carbonic acid; his experiments on the absorption of nitrogen; his conclusion that carbonic acid is sometimes given out by the lungs when no oxygen has been inhaled; objections to his views.

Does free carbonic acid exist in the blood?

5. Respiration of various Gases.

Respiration of different proportions of oxygen and azote, or oxygen and hydrogen; of pure oxygen; of nitrous oxide; of pure hydrogen or nitrogen; of deleterious gases; pure carbonic acid; diluted do.; chlorine, &c.; carburetted hydrogen; gases which suffocate, and gases which poison.

6. Remarks on the Morbid Changes arising from imperfect performance of the Respiratory Process.

§ 24. ASPHYXIA. Insensibility or apparent Death caused by the cessation or impaired condition of the Respiration.

1. Nature and Causes of Asphyxia.

Definition of asphyxia; different kinds of it; distinction of asphyxia from syncope, and from the coma of apoplexy.

Causes of asphyxia; deprivation of air by immersion in irrespirable gases; drowning; strangulation by simple closure of the windpipe, as in choking, or this combined with obstructed circulation in the head, as in hanging; non-dilatation of the chest, from palsy of the respiratory muscles; accumulation of fluid in the lungs or chest.

2. Phenomena of Asphyxia.

Order in which the different phenomena of asphyxia appear; 1. passage of dark blood to the left side of the heart; 2. diminution in the quantity of blood passing through the lungs; 3. loss of consciousness; 4. convulsive respiratory motions; 5. stoppage of the passage of blood through the lungs; 6. cessation of the heart's action; 7. complete death.

Length of time after the cessation of respiration at which these appearances present themselves; circumstances modifying this.

Length of time that persons can remain below water without breathing; influence of heat, season, &c. on this; experiments of Edwards and others.

Greater power possessed by the young than by the adults of some animals to live for a considerable time without breathing.

State analogous to asphyxia in hybernating animals; total cessation of respiration in some of these animals; experiments of physiologists regarding the bat, hedgehog, marmot, dormouse, &c.

Appearances after death in persons dying of asphyxia.

3. Theory of Asphyxia. Explanation of the Causes of its different Phenomena.

Cause of the loss of consciousness; theory of Goodwyn and Bichat; that it is dependent on the arrival of venous blood at the brain; experiments of Kay, and his objections to Bichat's view.

Cause of the cessation of the respiratory motions.

Causes of the cessation of the heart's action; over distention on the right side; want of the stimulus of the blood on the left; experiments in proof of this.

4. Means to be adopted for the recovery of Asphyxiated Persons.

Artificial Respiration; how to be performed; danger of violent insufflation of the lungs: application of warmth: friction: internal stimulants: galvanism; the use of this agent in restoring the action of the heart.

25. INFLUENCE of RESPIRATION on the CIRCULATION of the Blood in the Adult and Fœtus.

1. In the Adult.

Action of the atmospheric pressure, during inspiration, on the blood flowing in the veins; swelling in the jugular veins during expiration.

Increased velocity and impetus of the stream of blood in the arteries during expiration; inequality of the strength of the pulse corresponding with this; experiments of Haller, Lamure and Lorry, Magendie and Poiseuille. Effect of this inequality on the bursting of aneurismal tumors, apoplectic effusions, &c.

Circulation of the blood in the brain; how modified by the incompressible nature and closed condition of the parietes of the skull; alternate elevation and depression of the brain, seen through the fontinelles of the infant's head, or in the head of the adult when part of the skull has been removed.

2. In the Fœtus.

Peculiarities of the fœtal circulation. First respiration in the child; its cause; effects of the commencement of respiration on the course of the blood, the action of the heart, &c. in the newly born infant.

§ 26. ANIMAL HEAT, or Constant Temperature of Man and Animals.

1. Temperature of Animals.

Diversity in the temperature of the human body at different parts; at different periods of life; remarkable state of inability to maintain their heat in which the young of some animals are born; experiments of Legallois, Edwards, &c.: Varieties of temperature in different animals; warm and cold blooded animals; circumstances modifying the temperature of animals; power of animals to resist heat as well as cold.

2. Source of the Temperature of Animals, or Theory of Animal Heat.

Theory that animal heat is dependent on the changes of the blood in the lungs; chemical experiments favouring this opinion: views of Mayow, Black, and Lavoisier. Modification of this view by Crawford and Irvine; objections to their theory in the contrary experiments of John Davy, Dulong, and Despretz.

Theory that animal temperature depends on the influence of the nervous system; pathological observations of Earle and others; experiments of Elliot, Bichat, and Brodie; later experiments of Legallois, W. Philip, Chossat, and Williams, and observations on the temperature of the series of warm-blooded and cold-blooded animals, hybernating animals, &c., making it probable that this process is more intimately and directly connected with the respiration and circulation than with nervous influence.

§ 27. Review of the FUNCTIONS of CIRCULATION and RESPIRATION in Animals and Plants.

Intimate connection of these functions with one another; importance of an accurate knowledge of them to Physiology in general.

Diffused circulation and respiration in animals in which no perceptible special organs for the performance of these functions exist; external motions which in some degree supply the place of these organs.

Simplest kind of circulatory organs in animals, and respiratory organs connected with them; in Avertebrated animals; Zoophytes, Entozoa, Annelides, Insects, Crustacea, and Mollusca. Different kinds of blood in these animals; its globules.

Circulation and respiration in Vertebrated Animals; Fishes, Amphibia, Reptiles, Birds and Mammalia; structure of the heart in fishes, and changes in it which are observed as we pass from fishes to reptiles and warm-blooded animals: respiratory organs for breathing water, gills: those for breathing air, lungs: animals possessing both kinds of respiratory organs or amphibious animals.

Varieties in the chemical change effected by the respiration of the animals of each of these classes, on the composition of their blood and reciprocally on the air.

Comparison of the circulation and respiration in plants and animals; no true circulation in common dicotyledonous plants; motion of their sap, how effected; motion of the sap in monocotyledonous and cellular plants; circulation and other motions of the sap in the *Chara flexilis*, *Ficus elastica*, &c.

Currents occurring within the bodies of animals, and on their exterior, which are not attributable to muscular contractions, and in many instances connected with the respiratory function; in Zoophytes, Mollusca, and the Larva of the Batrachia; occasional production of these currents by cilia; observations of Grant, Sharpey, Carus, and Raspail.

Evolution of carbonic acid from plants during their ordinary respiration. Evolution of oxygen from them in sun-light. Theory of Priestley, that the composition of the atmosphere is thus maintained uniform by the respiration of plants: experiments of Davy, Ingenhouz, Senebier, and Ellis; theory of the coloration of plants; Ellis's experiments and conclusions.

CHAP. V. NUTRITION,

The application of the Blood to the Growth, Nourishment, and to the Support of the Vital Powers of the Body.

§ 28. Introductory Remarks on the Nature of the Functions included in this Chapter, and on the THEORY of NUTRITION.

The general structure of the body, as composed of textures, systems, and organs. Enumeration and description of the elementary and compound textures of the body; cellular texture, cutis, fat; mucous membrane; serous membrane; nervous substance; muscular fibre; vascular texture, erectile texture, substance of glands; bone, teeth, cartilage, tendon, ligament, yellow elastic texture, fibro-cartilage, fibrous membrane; colouring matter; epidermis, nails, hair, horn, &c.

Apparatus concerned in nutrition; minute bloodvessels; exhalent, serous vessels, &c.; parenchyma.

Change of the blood from arterial to venous in the parenchyma of different organs; its change of colour and composition.

Moulding power of the nutritive vessels. Interstitial absorption. Vis plastica; experiments made with madder and otherwise, proving the continual removal and renewal of the elementary constituents of the body. Symmetrical form of the body; differences in the size and strength of the parts on the right and left side.

Differences of nutrition in youth, prime of life, and old age.

§ 29. Mode of Growth of different parts, the Formation of Bloodvessels and the Reunion of Divided Parts.

Origin and growth of bloodvessels in the young of cold-blooded animals, of Birds and of Mammalia.

Origin and growth of bloodvessels in the reunion of wounds of cold and warm-blooded animals; incised wounds, ulcers, granulation; false membranes; adhesions. Cicatrisation.

Reunion of divided parts; modifications of this process according to the texture of the body in which it occurs.

Reunion of parts that have been entirely separated from the body.

§ 30. Regeneration of the different TEXTURES, and of lost parts of Animals.

Regeneration of parts in the simplest kinds of animals; of the whole body of some animals from a part; of large parts of the body, when removed, as the head of the snail, tail and limbs of the newt, &c.

Reproduction of Textures in the higher animals; of cellular texture, bone, epidermis and rete mucosum of the skin, serous membrane, mucous membrane, spleen, nerves, &c.

Muscle, cartilage, tendon, true skin, the teeth, substance of the lung, glands, &c., are not in general regenerated.

CHAP. VI. SECRETION,

The Separation from the Blood of various Fluids not immediately subservient to the purposes of Growth.

§ 31. General Nature of the Secretory Action.

1. Structure of the Organs of Secretion.

Exhalent secretory organs, or exhalent surfaces of membranes.

Crypts and follicles in skin, or mucous membranes; simple and compound; sebaceous and ceruminous; intestinal glands of Peyer and Brunner; meibomian glands.

Glands; their division into conglomerate and conglobate; their general structure; opinions of different anatomists respecting the connection of the bloodvessels with the excretory ducts; Malpighi, Ruysch, &c.; late investigations of J. Müller, E. H. Weber, and others, shewing that there is never any direct inosculation between them.

Structure of the lymphatic glands; of the thymus and thyroid glands; of the spleen, &c. in which no obvious excretory ducts have been shewn.

2. Mode in which Secretion takes place. Theory of Secretion.

Is the blood altered solely in the gland or secreting part, or is it changed before arriving at them? experiments on urea found in the blood after extirpation of the kidneys; on the bile.

Does venous blood serve for secretion as well as arterial blood?

Rapidity of secretion in different secreting organs. Recent experiments on this subject.

Influence of the nerves on secretion.

3. Arrangement of the different Secreted Products.

Their division into excrementitious and recrementitious; other classifications, chemical and physiological.

A—Exhalation or Secretion; 1. Of watery vapour from the surface of the skin or insensible perspiration, and from the mucous lining of the lungs. 2. Of watery fluid from the surface of the skin or sensible perspiration, and from mucous membranes. 3. Of serous fluid, from the Arachnoid membrane, the pleura, pericardium, peritoneum, and tunica vaginalis. 4. Of synovial fluid, from the synovial membrane of joints, and from the bursæ and sheaths. 5. Of mucous fluid from the lining of the air-passages and lungs, of the alimentary canal, genito-urinary organs, surface of the excretory ducts of glands. 6. Of menstrual blood from the interior of the uterus.

B—Secretion of peculiar fluids from crypts; 1. From simple crypts or follicles, mucus from Peyer's and Brunner's glands, gastric juice, fluid of the cœcum, sebaceous matter of the skin, cerumen of the external auditory meatus. 2. from compound crypts, matter from the tonsils, caruncula lacrymalis and meibomian glands.

C—Secretion from the Glands properly so called. The saliva, pancreatic fluid, bile, urine, tears, semen, prostatic fluid, milk.

D—Secretion from so called Glands, without excretory ducts; from the lymphatic and mesenteric glands, from the spleen, thyroid, and bronchial glands, thymus gland and supra-renal bodies.

§ 32. Cutaneous and Pulmonary Exhalation and Absorption.

Transpiration of moisture from the surface of the skin; sensible and insensible perspiration; their quantity in a given time; analysis of the perspired fluid. Exhalation of moisture from the internal surface of the lungs; its nature; mode of estimating its quantity.

Influence of a change of temperature on the quantity of moisture exhaled from the skin or lungs; influence of food, sleep, moisture of the atmosphere, &c.; experiments of Edwards and others.

Absorption of substances by the surface of the skin or lining membrane of the lungs; experiments of Seguin, Currie, Perceval, Magendie, Dill, Klapp, Rousseau, and others, shewing a variety in this respect in different substances; experiments of Barry and Ellerly on the effect of atmospheric pressure on absorption of substances by the skin. (See also § 10.)

Influence of physical agents, as heat, light, and electricity, and of climate on the body generally.

§ 33. URINARY and other SECRETIONS not previously treated of.

1. Urinary Secretion.

Structure of the kidneys.

Quantity of urine secreted daily; rapidity with which this secretion goes on, and with which substances pass by the urine when they have been taken into the stomach, or otherwise introduced into the system; experiments of Wöhler, Stehberger, Tiedemann, and others.

Effect of extirpation of the kidneys on animals; urea found in the blood; experiments of Richerand, Comhaire, Prevost, Dumas, and Mayer.

Analysis of the urine; urea, lithic acid, albumen, salts, &c.; ultimate analysis of lithic acid and urea; artificial urea.

Alterations of the urine by disease; diabetic urine; urinary concretions.

2. Other Secretions.

§ 34. General Review of the processes of the NUTRITIVE FUNCTION, with a relation to the Ingesta and Egesta.

Theory of the elimination of different elementary constituents from the body, and their replacement by others; of carbon from the lungs, carbon and hydrogen from the liver, and nitrogen from the kidneys.

Average weight of the body, and circumstances connected with nutrition influencing it; observations of Bryan Robinson, Dalton, and others.

DIV. II.—REPRODUCTIVE FUNCTIONS.*

§ 35. Introductory View of the REPRODUCTIVE FUNCTIONS in Animals.

Theory of supposed spontaneous, or so called Equivocal Generation. Observations on the confervæ, infusoria, and entozoa.

Reproduction in animals in which there is no difference of sex; in animals in which the male and female sexual organs are on the same individual, or Hermaphrodites; self-impregnation and mutual impregnation.

Reproduction in animals in which the different sexual organs are on different individuals; oviparous, viviparous, and ovo-viviparous animals; differences between them; and varieties in the mode of impregnation, gestation, and formation of the fœtus dependent on these differences.

CHAP. I. REPRODUCTIVE FUNCTIONS CONNECTED WITH THE ADULT ANIMAL,

The various Functions performed by the Male and Female concurring to the production of the Young.

§ 36. Structure and Functions of the Organs of Reproduction in the Male.

Structure of the testicle, seminal ducts, vesiculæ seminales, &c. of the penis, and external organs; varieties in the structure of these organs in animals.

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* *Note.*—The Division comprehending the Reproductive functions is treated of after the Animal functions in the Lectures, but is placed second in this syllabus, in conformity with the general division of the functions into Nutritive, Reproductive, and Animal.

Functions of these organs. Phenomena and causes of the erection of the penis. Emission of the seminal and prostatic fluids; circumstances modifying their secretion; chemical composition of the seminal fluid; its other properties; the seminal animalcules; differences of these in animals.

Changes of the body occurring on the arrival of puberty in the male.

Effects of castration on the male.

§ 37. Structure and Functions of the Organs of Reproduction in the Female.

Structure of the internal organs of reproduction; the ovaries, Graafian vesicles and ovula contained in them. The uterus, fallopian tubes; infundibula.

Varieties in the structure of these organs in animals.

Structure of the external organs. The vagina, nymphæ, clitoris, and labia; analogy of these parts to the external male organs.

Functions of the internal organs in the female; functions of the ovaries; formations of the vesicles of De Graaf and the ovula or small vesicles of Baer within them; functions of the uterus and vagina.

Flow of the menstrual fluid in the human female; does menstruation occur in any other animals? circumstances modifying this action; the source of the fluid; conjectures regarding the cause of its flow; duration of the flow of this fluid, and period of life during which it continues.

Changes attendant on the arrival of puberty in the female; age at which this occurs; difference in different nations; peculiarities in the structure of the female body generally; effect of the removal of the ovaries on the functions of the female.

Structure and properties of the male and female organs of reproduction in hybrids or mules.

§ 38. Discharge of the Ovula from the Ovarium. Conception. Fecundation of the Ovula.

1. Discharge of the Ovula from the Graafian Vesicles of the Ovaria.

Formation of the ovula, or vesicles of Baer; comparison of the ovula of mammiferous animals with the yolks of the bird's egg; vesicle of Purkinje.

Circumstances giving rise to the bursting of the Graafian vesicles, and the escape of their contents; union with the male; state of heat or rutting in some animals; simultaneous disappearance of the vesicle of Purkinje, in the ovula of oviparous animals.

Changes occurring in the *ovulum* of mammiferous animals after its escape from the Graafian vesicle; observations of Baer, Coste, and Jones: comparison of these with the changes occurring during the descent of the yolk of the egg of birds and other oviparous animals in the oviduct; the addition of the parts constituting it a perfect *ovum*.

2. Conception, or the phenomena which precede and accompany the fixing of a perfect and fecundated Ovum in the Uterus.

General and local signs of conception in the human female; circumstances influencing its occurrence; state of health, age, and menstruation; pregnancy; lactation; time of year, climate; state of the reproductive organs themselves; rutting of animals.

Changes in the ovaries and fallopian tubes before and after conception: embracement of the ovarium by the infundibulum; duration of this; its connection with the bursting of the ovarian vesicles and the passage of ovula into the fallopian tube: formation of the corpus luteum; varieties in animals in regard to this; instances of animals in which the corpus luteum is sometimes formed without sexual union; views of Haller, Baer, and others; opinion of Sir E. Home; objections to it. Use of the corpus luteum unknown.

Changes in the uterus before and after conception; exudation of the lymph afterwards forming the membrana decidua; consequent closure of the mouth of the uterus: can a second conception occur after a first has been fruitful? and how long after it? superfetation.

3. Fecundation of Ova, by means of the Seminal Fluid.

Nature of this process; experiments proving that actual contact of the ova and seminal fluid is necessary; artificial impregnation; supposed importance of the seminal animalcules in fecundation; experiments of Spallanzani, Prevost, and Dumas; circumstances modifying the fecundating power of the seminal fluid, degree of dilution, time after emission, &c.; circumstances modifying the susceptibility of the ovula to be fecundated.

In what part of the female organs does fecundation of the ova take place? Experiments of Cruikshank, Haighton, Blundell, Prevost and Dumas; reasons for believing there is a variety regarding this; instances in which the ovum has become developed near the ovary, or in the fallopian tube.

Hypothesis of the aura seminalis.

Effects of fecundation on the ovum itself.

§ 39. Utero-gestation or Pregnancy. Parturition. Lactation.

1. Utero-gestation or Pregnancy as regards the parent.

General and local signs of pregnancy; auscultation as a means of ascertaining it; changes which the uterus undergoes in size, form, position, and structure.

Anatomy of the gravid uterus, use of the broad and round ligaments; state of the arteries and veins; supposed increase of the solid substance of the uterus; position of the fœtus in the gravid uterus.

Structure of the placenta; general position of the placenta in the uterus; view of the Hunters, that the arteries and veins of the mother are prolonged into the placenta, correct; Robert Lee's observations and theory.

Effects of pregnancy on the functions of the body generally, on digestion, circulation, &c.; nervous affections.

Influence of the functions generally on utero-gestation; supposed influence of mental emotions and bodily injuries in the mother on the fœtus.

Duration of pregnancy; result of observations on this subject; ordinary mode of dating the commencement of pregnancy: period of quickening; variations in this.

2. Parturition or expulsion of the child from the uterus.

Structure of the pelvis and other parts concerned in parturition; size of the apertures of the pelvis: size of the child's head and body.

Mode of expulsion of the fœtus in parturition; contractions of the uterus;

their nature; circumstances promoting or retarding them; rupture of the membranes; expulsion of the membranes and placenta.

Circumstances giving rise to abortion or premature birth.

Puerperal condition; collapse of the uterus after pregnancy, and its return to the unimpregnated condition.

3. Varieties in births.

Number of children in families; circumstances influencing this; number of children at one birth; proportion of twins, triplets, &c.; relative proportion of male and female children.

4. Lactation. Secretion of milk and nursing.

Structure of the mamma.

Secretion of the milk, its quantity; varieties; chemical composition and properties; differences in animals.

CHAP. II. DEVELOPMENT,

Formation of the Fœtus from the Ovum.

§ 40. Introductory Remarks on the Theories of Development of the Fœtus.

General view of the phenomena of development or formation of the fœtus in animals; history of the earlier opinions respecting this subject; those of Aristotle, Fabricius, Harvey, Malpighi, &c.; theories of *evolution* and *epigenesis*, or of gradual appearance and superformation of parts: Modern theory of *development*. Observations of Wolff, Haller, Pander, and others.

§ 41. Structure of the Fecundated Ovum in Vertebrated Animals.

Egg of oviparous animals; of ovo-viviparous animals: egg of viviparous animals. The yolk, its granular substance and membrane; cicatricula or germinal disc; chorion or external covering of the egg.

§ 42. Changes of the Ovum of Vertebrated Animals during Development.

Incubation of the egg of oviparous animals; artificial incubation; loss of substance, and chemical changes occurring during the process.

Formation of the germinal membrane in the egg of the fowl and mammiferous animals; development of the rudimentary parts of the fœtus from the central part of the germinal membrane; primitive trace. Formation of new membranes in the egg from the extended peripheral part of the germinal membrane. Decidua, chorion, endo-chorion and allantois, umbilical vesicle, amnios. Observations of Dutrochet, Cuvier, and others.

§ 43. General Phenomena of the Development of the rudimentary parts of the Fœtus in the egg of the Fowl and of some Mammiferous Animals.

1. In the egg of the fowl.

Division of the germinal membrane on the surface of the yolk into three layers, serous, vascular, and mucous.

Rudimentary trace of the embryo in the serous or external layer of the germinal membrane ; determinate position of this trace in the egg ; formation of the primitive folds in the same layer ; closure of these folds and formation of the cerebro-spinal canal. Origin of the mass of the head, trunk, and extremities of the body : cephalic, caudal and abdominal folds ; rudiments of the vertebræ. First origin of the brain and spinal marrow ; first formation of the organs of the senses.

Formation of the heart and bloodvessels in the middle or vascular layer ; origin of the blood in the vascular area of the cicatricula.

Formation of the alimentary canal, glandular and urino-genital organs, in the combined vascular and mucous layers.

Observations of Baer, Rathke, and others.

2. Comparison of the observations that have been made in mammiferous animals and in man, with the above mentioned general facts.

§ 44. Development of the Individual Organs of the Fœtus ; 1st, Of the Nervous System.

Origin of the brain and spinal marrow in the cavity formed by the union of the primitive folds ; division of this cavity into three compartments, in which originate respectively the cerebral lobes, the optic tubercles, and medulla oblongata ; origin of the cerebellum and spinal marrow.

Change of relative position that takes place in these parts as the cerebral lobes enlarge ; primitive hollow state of the optic tubercles ; the cavity filled up with grey matter : further development of the parts of the brain ; crura cerebri, thalami optici, corpora striata, &c. Formation of grey matter, and convolutions upon the surface.

Development of the organs of sense ; formation of the eye ; of the ear ; mouth and nose.

Development of the sympathetic system of nerves.

Differences of development of the nervous system in animals. Comparison of different states of the fœtal brain with its forms in different adult animals.

§ 45. Development of the Circulatory and Respiratory Systems.

1. Origin and development of the heart.

Origin of the heart in the form of a simple tube ; formation of its auricular and ventricular parts and bulb of the aorta ; separation of the ventricular part into the right and left ventricles ; communication existing between the ventricles for a time ; double appearance of the ventricles externally in some mammalia. Formation of the septum of the auricles, the eustachian valve; foramen ovale; its valve.

2. Origin and development of the arteries coming off from the bulb of the aorta, and in other parts of the body.

Trunk of the aorta; its primitive double state; formation of five branchial vascular arches on each side of the neck in the fœtus of all vertebrated animals; transformations which these undergo in different animals in the formation of the aorta, pulmonary arteries and brachio-cephalic trunks.

Development and growth of other arteries of the body.

Formation of the veins.

3. Development of the respiratory organs.

External and internal gills of aquatic animals; rudiments of gills in the fœtus of higher animals. Development of the trachea, larynx, and lungs; vesicular lungs of reptiles; lungs and air-cells of birds; lungs of mammiferous animals.

4. Peculiarities in the circulation of the blood at different periods of fœtal life.

Peculiarities of structure in the organs of circulation in the fœtus: foramen ovale, ductus arteriosus and venosus. Description of the circulation in the human fœtus in the earlier and in the more advanced periods of development.

Nature of the connexion, by means of the placenta, between the fœtus and mother. How are the respiration and nutrition of the fœtus carried on? Action of the fœtal heart; number of its pulsations in a given time.

5. Changes which occur in the circulatory and respiratory organs after birth.

First respiration of the child. How is inspiration excited? Filling of the lungs with air and increased flow of blood to them; change in the course of the blood and closure of the foramen ovale, ductus arteriosus and venosus, effected by the commencement of pulmonary respiration.

§ 46. Development of the Alimentary Canal and Glandular Organs.

1. Development of the alimentary canal.

Primitive state of the intestinal tube; its communication with the cavity of the yolk; formation of the yolk-sac or umbilical vesicle; ductus vitello-intestinalis. Mouth and anus at first closed; formation of their apertures. Farther changes in the different parts of the intestines; formation of the stomach, cœcum, &c.; of the internal folds and villi of the mucous membrane.

2. Origin and formation of the glands.

Connexion of all the glands with the same part of the germinal membrane which gives rise to the alimentary canal; formation of the excretory ducts of the glands.

Development of the liver; functions of the fœtal liver. Development of the pancreas, spleen, thymus, salivary, and other glands.

§ 47. Development of the Genital and Urinary Organs.

Observations of Wolff, Rathké, Müller, and others, on the Wolffian body, and the origin of the kidneys and ureters; supra-renal bodies.

Early changes of development in the posterior part of the alimentary canal; Want of sexual difference in early fœtal life; the cloaca receives the orifices of the rudimentary ducts of the urinary and genital organs: connection of the bladder with the cloaca: origin of the bladder from part of the allantois.

Origin and development of the testicle, epididymis, and seminal ducts in the male; and of the ovaries, fallopian tubes, and uterus in the female, from similar and corresponding parts.

Development of the external organs of generation of both sexes; analogy of the male and female external organs; variety in their mode of development, which gives rise to their ultimate difference: hermaphrodism, epispadias and hypospadias.

§ 48. Development of the Fœtus in the Ovum of Avertebrated Animals.

Development in animals without proper ova, or in which there are only gemmules, such as most Radiata.

Development of the ova of hermaphrodite animals, such as most of the mollusca and the annelides.

Development of the ova of insects and spiders; metamorphoses of insects.

Development of the ova of the crustacea; supposed metamorphosis of the young of these animals.

§ 49. Review of the subject of Development.

Differences in the development of vertebrated and avertebrated animals. Proofs drawn from thence of differences in the type of their organization.

Theory of the analogy of the transitory states of the fœtus of higher animals with the permanent forms of those lower in the scale.

Various kinds of congenital malformation or deformity occurring in man and animals; attempts to explain the structure of monstrous productions, more especially by the knowledge of the development of the fœtus.

DIV. III—ANIMAL FUNCTIONS.

THE FUNCTIONS EXERCISED BY ANIMALS AND NOT BY PLANTS; THE FUNCTIONS OF RELATION OR THOSE CONNECTING THE ANIMAL WITH THE EXTERNAL WORLD.

CHAP. I.

General View of the Powers or Properties called Animal, and of the Functions of the Nervous System.

§ 50. The ANIMAL POWERS in General.

Feeling or Sensation as a power possessed by all living animals; Sensibility.

Motions of animals; cause of them, the alternate shortening and elongation of their soft parts on their being stimulated; Irritability.

Volition of animals; voluntary motion of the body or some of its parts.

Connection of the properties of sensibility and irritability with apparent nervous and muscular textures in the greater number of animals.

Comparison of the motions of some plants with those of animals; can plants be said to be sensible or irritable?

Gradual complication of the processes connected with sensibility and locomotility, observed in proceeding from the simple to the more complex animals; view of the more extended animal powers, or functions of relation in the higher animals.

Arrangement followed in treating of these functions.

§ 51. FUNCTIONS in General of the NERVOUS SYSTEM.

1. Structure of the Brain, Spinal Cord, and Nerves proceeding from them.

Chemical composition of nervous matter; fibrous nature of nervous matter; supposed globular constitution of some of its fibres, and hollow or tubular condition of others.

Structure of the brain; medullary or white, and cortical or grey matter; arrangement of the fibres of nervous substance in the brain; their alleged course, and the relation of the different parts of the brain to one another. Coverings and bloodvessels of the brain.

Structure of the spinal marrow; its fibres; grooves dividing it into different columns, anterior, posterior, and lateral; arrangement of the white and grey matter in the spinal cord.

Structure of the nerves; different kinds of nerves, according as they arise by single or double roots from the brain and spinal marrow; mode of their origin; different structure of the anterior and posterior roots of the spinal nerves. Neurilema; bloodvessels of the nerves; opinion of the supposed tubular nature of the nerves arising from the form of the neurilema, not of the nervous matter.

2. General properties of the Nerves, Spinal Marrow, and Brain.

Reception of impressions of sensation by the extremities of the sentient nerves; the conduction of these impressions along the nerves to the Brain.

Idea formed in the mind when these impressions reach the brain or Perception; other faculties constituting the immaterial mind; connection of these with the brain.

Conduction of stimuli along certain nerves from their central to their peripheral parts; to the muscles; the will and other stimuli: their influence in exciting muscular motions.

Simple nerves for sensation; simple nerves for motion; sensory and motory nerves; nerves combining both these properties or Compound nerves; double roots of the compound nerves; proofs that the posterior root gives sensory fibres, and that the anterior root gives motory fibres to these nerves: observations of C. Bell, Bellingeri, Magendie, and others.

Comparison of the origin, distribution and properties of the cerebral and spinal nerves.

Respiratory system of nerves of C. Bell; lateral column of the spinal marrow connected with these nerves.

General view of the properties of the different columns of the spinal marrow, and the different parts of the cerebrum and cerebellum, in reference to sense and motion: the brain as the seat of perception and other mental powers: influence of the brain necessary for sensation and perception; influence of the brain necessary to excite motions. Influence of the brain and nerves on the organic functions; nervous influence.

3. Structure, Distribution, and Functions of the Sympathetic or Ganglionic system of Nerves.

Dependence of sympathetic sensations and motions on connections of these or of other nerves.

Influence of the sympathetic system of nerves on the organic functions.

4. Comparative View of the Structure and Functions of the Nervous System in different Animals.

Ganglionic abdominal nervous cord of avertebrated animals; how far are the nerves of sensation, motion, and of nutrition distinct in these animals?

Brain, spinal cord, and nerves of vertebrated animals; difference in the relative size, and in the structure of these organs in different orders of vertebrated animals.

CHAP. II.—SENSATION AND SENSIBILITY.

The Functions connected with the reception of impressions of Sensation by the extremities of the Nerves, and the transmission of these impressions along the Trunks of Nerves to the Brain.

§ 48. General Phenomena and Laws of Sensation.

1. **Conditions necessary for Sensation.**

The presence of the impression which acts on the extremity of the nerves; the apparatus at the nervous extremities receiving the impressions; the integrity of the nervous trunk conveying the impression from its extremities to the brain; and lastly, the integrity of the brain for the completion of the sensation, the formation of the idea in the mind, or perception of the object giving rise to the impressions felt.

2. **Nature of the various impressions which give rise to Sensation.**

Sensible impressions of external objects; sensible impressions arising within the animal body; consequent division of the sensations into External and Internal.

General sensation throughout the body; what has been called Cœnaesthesis by some authors; varieties in this kind of sensation; sensations of pleasure and pain; feeling arising from the motion of parts of the body; heat or cold; lightness or heaviness of the body.

Enumeration of the various kinds of impressions recognised by our feelings and remarks on their nature.

3. **Connection of Sensation with the Nervous System.**

a. Reception of sensible impressions by the extremities of the nerves.

Structure of the extremities of the nerves and of the textures in which they are placed, or of the apparatus by which they are accompanied, fitting them for the office of receiving sensible impressions; nervous textures of the skin, mucous membranes, tongue, nose, eye, ear, &c.; remarks on the sensibility of different parts of the body.

Change in the nervous substance supposed to accompany sensation; our ignorance of its nature.

Circumstances affecting the duration, intensity, and other qualities of the impressions of sensations; as repetition, habit, temperature of the sensitive part, its state of health and nutrition, quantity of blood in it; variety in these qualities proceeding from inflammation of the sensitive organ; the application of stimulant or sedative substances to it, &c.

b. Conduction of sensible impressions by the trunks of the nerves.

How far this conduction is affected by division of the nerve; difference in the effect of simple division, and division accompanied with the extraction of a part of the nerve; conduction of sensations by nerves reunited after division: effect of the application of various substances, narcotics and others, to the trunk of a sensory nerve.

Sympathetic conduction of sensations as it occurs through nerves.

c. Detailed account of the experiments which tend to establish the functions of particular sensory nerves.

Posterior or ganglionic roots of the spinal nerves; the difference in their functions from the anterior or motory roots. Discovery of the functions of these roots by Sir C. Bell; experiments by Magendie and others, confirmatory of Bell's view. Bellingeri's view that both anterior and posterior roots exercise a sensory function, and derive their sensory fibres from the grey substance of the spinal marrow. Recent accurate experiments of J. Müller and others, demonstrating the sensory function of the posterior and motory function of the anterior roots.

Analogy in the structure and functions of some of the cerebral with the double spinal nerves.

Sensory function of the ganglionic root of the fifth pair of nerves; the nerve of common sensation in the face. Proofs of this from experiments on animals, from pathological observations, and surgical operations in man; researches of C. Bell, Bellingeri, Mayo, Magendie, Eschricht, and others. Distribution and uses of this nerve in animals; observations of Treviranus, Rapp, and others.

The pneumogastric a ganglionic nerve, and obviously endowed with some sensory function: experiments of Legallois, Brachet, and others.

The glossopharyngeal also a ganglionic nerve, and exercising in some degree a sensory function.

The facial nerve or portio dura of the seventh pair generally regarded as the motory nerve of the face. Reasons for believing it to have some power of sensation; slight pain observed in some animals and in man, on its being pricked or cut. Bellingeri's view of the sensory function of this nerve probably erroneous. The anastomosis of its twigs with those of the fifth pair of nerves may serve to explain its apparent sensory power. Observations of Bell, Mayo, Magendie, Eschricht, and others.

Mayer's observations shewing the occasional presence of a posterior or ganglionic root for the hypoglossal or ninth pair of nerves.

Sensory functions of the nerves of the external or special senses set aside for the reception of particular kinds of impressions only, as the olfactory, optic, acoustic, and lingual nerves. (See § 49, Smell, Vision, Hearing, and Taste).

Do the twigs of the sympathetic system of nerves possess any sensory power? Experiments seem to shew that they do in some degree. Is this power to be considered as belonging to the fibres of the sympathetic nerve itself, or is it to be attributed to the mixture with these fibres of others derived from the cerebro-spinal sensory nerves?

d The dependence of sensations on the brain and spinal cord postponed to § 57.

4. Arrangement of the Sensations, and remarks on the first class, including the five special or external senses.

§ 49. External or Special Senses and their Organs. Touch, Taste, Smell, Hearing, and Vision.

1. Touch.

Nature of the impressions examined by this sense; simple sensations produced by the contact of bodies ; judgment formed from the sensations of touch of the form, size, hardness, temperature, and other qualities of the surfaces of bodies ; power of estimating the resistance and weight of bodies by means of the sense of touch. Feeling produced by simple contact, *tact*. Compound tactile feeling accompanied with muscular effort constituting *touch*.

Structure of the skin, fitting it to serve as the organ of touch ; its villi or papillæ ; tips of the fingers, the lips, and tongue ; relation of the epidermis to touch. Parts connected with the skin, such as nails, hairs, bristles, moustaches of animals.

Nerves of the sense of touch, their distribution in the tactile organs.

Variety in the delicacy of the sense of touch in different parts of the skin ; experiments of H. E. Weber, shewing that this may be accurately measured. Modification of the sense of touch according to different states of the skin ; effect of the dryness or moisture, temperature of the skin, pressure upon it, &c. Increased delicacy of the sense of touch in parts where it has been frequently exercised ; examples of the high cultivation of this sense in the blind.

Diseased state of the sense of touch ; total loss of the power of touch or anaesthesia ; morbid increase or diminution of its acuteness from inflammation, application of stimulant or narcotic substances, &c. ; feelings of itching and of tingling in the skin.

2. Taste.

Nature of the impressions recognised by the sense of taste ; simple sapid sensations ; attempts made to arrange their different kinds, as sweet, sour, salt, bitter, acrid, pungent, &c. ; sense of touch accompanying taste in the mouth, and to be distinguished from it. Is flavour intermediate between taste and smell, or wholly of the nature of the latter sensation ? What state of solution of the sapid particles is necessary to excite taste ?

Structure of the organ of taste. The mouth and tongue ; mucous membrane and epithelium ; papillæ of the tongue, filiform or conical, fungiform, and vallated.

Nerves of taste ; experiments shewing that the lingual branch of the fifth pair is a nerve of touch as well as of taste ; partial sensory function of the glossopharyngeal nerve ; experiments and observations of C. Bell, Mayo, Magendie, Scarpa, Parry, &c.

Different degrees of sensibility to taste of different parts of the palate and tongue ; experiments of Volta, Daniels, and Horn, shewing that different papillæ are affected by different kinds of taste.

Sympathetic sensations of taste.

Differences in the organ and function of taste observed in different animals.

3. Smell.

Nature of the impressions recognised by the sense of smell ; attempts at the classification of odours. In what state, of solution or otherwise, do odours affect the organ of smell ? Experiments of Stark on the various degree to which different substances absorb and give out different odours.

Structure of the nasal passage as constituting the organ of smell.

Nerves of smell, first pair of cerebral or olfactory nerves ; nerves of touch of the nasal passages.

Connection of smell with the motions of inspiration and expiration.

Difference in the sensibility to odours of different parts of the nasal passages ; much greater delicacy of this sense in the upper meatus. Sensations of touch belonging to the lining of the nasal passages. Experiments on the function of the olfactory nerves ; opinion of Magendie that the fifth, and not the first, is the nerve of smell ; his experiments do not warrant the conclusion : contrary experiments of C. Bell and Eschricht ; observations of the absence of the olfactory nerve in persons in whom the sense of smell had been wanting ; state of the nasal passages and deficiency of the olfactory nerves in some Cetacea.

The frontal, ethmoidal, and other sinuses communicating with the nasal passages, and connected rather with the form and support of the face than with smell ; experiments of Deschamps and Richerand, shewing that there is no sense of smell in the sinuses.

Sympathetic affections of smell ; sickness or fainting occasioned by some odours.

Varieties in the organ and function of smell in different animals.

4. Hearing.

A. Nature and Properties of Sound.

Vibrations of aeriform, liquid, and solid bodies which occasion sound ; circumstances giving rise to differences in the qualities of sound, as in their tone, strength, timbre, &c. ; musical sounds as distinguished from noises.

Transmission of sound from one body to another ; greater or less perfection and velocity of its passage in different media.

B. Structure of the organ of Hearing, fitting it for the reception of sonorous impressions.

External, middle, and internal parts of the ear ; their uses generally considered. Cartilage, canal, and ceruminous glands of the external ear ; the motions of the cartilage very limited. Middle part of the ear consisting of the cavity and membrane of the tympanum, the chain of small bones, Eustachian tube, mastoid cells, oval and round holes. Internal ear or labyrinth ; cavity of the vestibule ; cochlea ; semicircular canals ; internal auditory meatus ; auditory nerve ; aqueducts of Cotunnius.

C. Transmission of sounds from without to the auditory nerve, and uses of different parts of the organ of hearing.

Collection of the scattered sonorous vibrations of the air by the convoluted external auricle ; their transmission through the external auditory canal ; their impingement on the membrane of the tympanum : are the vibrations thus occasioned in the membrane of the tympanum in accord with those producing the sonorous vibrations that strike upon it ? opinion of Savart : inquiry how far the chain of bones and their muscles assist this accordance by rendering the membrane of the tympanum more or less tight : proof from the effect of disease that the integrity of the membrane of the tympanum is not essential for the transmission of sounds to the internal ear ; we are ignorant of the use of this membrane.

Inquiry whether sounds are conveyed through the tympanum by the air it contains, or by the chain of small bones ; proofs that it is chiefly by the former, from the deafness occasioned when the vibratory motions of the air in the tympanum are confined by any obstruction of the Eustachian tube ; from the effects of perforating the membrane of the tympanum in such instances ; and from the circumstance that removal of the malleus and incus is not always attended with total or even considerable deafness ; Sir A. Cooper's cases.

Inquiry whether sounds are transmitted from the tympanum to the labyrinth by the bony partition between them, or by the membranes closing the fenestrae ovalis and rotunda.

Manner in which the vibrations of sound may be supposed to arrive at the auditory nerve; the pulp and fluid of the labyrinth essential to hearing; is this fluid thrown into vibrations by the sounds reaching it? how may the auditory nerve be supposed to be affected by sounds; use of small stony bodies in the vestibule; of the aqueducts of Cotunnius; conjectures regarding the functions of the cochlea and semicircular canals; experiments of Flourens on the effect of destruction of different parts of the labyrinth unsatisfactory.

Conduction of sounds to the auditory nerves by the bones of the head; experiments of Chladni and Gordon.

Varieties in different individuals as to the range of sounds which they are capable of hearing; Wollaston's observations; very acute and very grave sounds heard by some, and not by other persons; explanation of this by Savart.

We estimate the distance of sound by the feeling of its intensity, a judgment being at the same time formed as to its nature: we estimate the direction of sound by moving the head until the sound appears loudest, which is, when the external meatus is in a line parallel to the direction of the sounding body; the deception of the ventriloquist depends, in a great measure, on the difficulty we have in judging of the intensity, kind, and direction of sounds.

Pleasure derived from the succession of musical sounds; harmony and melody; musical ear an original feeling; memory of sounds; cultivation of these powers.

Sympathetic affections of the organ of hearing.

Structure and functions of the organ of hearing in different classes of animals.

5. Vision.

A. Nature and properties of Light.

Sources of light. Theories respecting its nature.

Passage of light from one body to another; its velocity: radiation of light through space or transparent media: reflection of parallel, converging and diverging rays of light from plane, convex, and concave mirrors: refraction or change of the course of the rays of light in passing through transparent media of different densities; prism; convex and concave lenses; spherical aberration of lenses; how this defect is corrected.

Dispersion or separation of the coloured rays of light by the prism or lenses; achromatic lenses.

B. Structure of the Eye as an optical instrument, and the organ of Vision.

Comparison of the eye with the camera obscura, and general account of the uses of its principal parts in the function of vision.

Structure of the eye-ball; its size and figure; its coats; sclerotic; cornea; choroid, its pigment and vascular part; ciliary body; canal of Fontana; ciliary processes; the iris, its muscular fibres; retina or expanded optic nerve; membrane of Jacob. Transparent humors; aqueous humor; membrane lining the aqueous chamber: crystalline lens; its concentric layers and alleged fibrous structure; capsule of the lens; canal of Petit: vitreous humor; hyaloid membrane.

Anatomical structure of the accessory parts of the eye; muscles of the eyeball; nerves; meibomian glands; lacrymal glands and ducts; cilia; orbit.

C. Function of Vision.

1.—Passage of rays of light through the transparent parts of the eye-ball, so as to give rise to an image and impression on the retina; proofs of this derived from experiments on the eyes of dead animals.

Effect of the different transparent parts of the eye in altering the direction or refracting in a determinate manner rays of light which pass through them; manner in which an image of any visible object is inverted in the retina. Refracting action of the cornea; radius of curvature of the cornea; varieties in this respect in different individuals; observations of Brewster and Treviranus. Refracting action of the aqueous humor. Refracting action of the crystalline lens; focal distance of the whole lens; difference in the curvature of the anterior and posterior surfaces of the lens; greater density and greater refracting power of the central than of the external parts of the lens. Refracting action of the vitreous humor.

Arrival of the rays of light at the retina, and formation of an image on that nervous membrane; adaptation of the concave form of the retina to receive the rays in such a way as to render the image perfect; use attributed to the black pigment of the choroid coat of absorbing scattered rays of light not employed in forming the image; supposed use of the shining tapetum in the eyes of some animals.

General similarity of the action of the transparent humors of the eye to that of a compound convex lens. Effect of the arrangement of these humors, and more especially of the structure of the lens in preventing the spherical aberration of the rays of light. Effect generally attributed to the humors of preventing the dispersion of the coloured rays and of thus rendering the eye achromatic; experiments of Maskeleyne, Wollaston, and Young in favour of, and of Haldat and Brewster in opposition to, this opinion.

2.—Use of the iris or moveable curtain placed in the chamber of the aqueous humor. Analogy of the iris with the diaphragm placed between the glasses of optical instruments; effect of its contraction in rendering the image of an object more distinct by cutting off those rays which do not converge on the retina.

Motions of the iris. Contraction of the pupil from increase, its dilatation from diminution of light falling on the eye; experiments of Fontana, shewing that these motions depend upon the passage of light throughout the pupil into the interior of the eye-ball, and not simply upon their falling on the iris itself; their cause not explained; various opinions regarding it; Tiedemann's opinion. Argument drawn from the fact, that in cataract and amaurosis, the iris frequently, though not invariably, ceases to be affected by a change in the quantity of light falling upon the eye. The iris capable of being excited to contraction by the galvanic stimulus after death; experiments of Nysten, shewing this in criminals; experiments of Mayo on the irritation of the iris through the third nerve; effect of the division or destruction of the optic nerve.

The motions of the iris probably depend on muscular fibres of a circular kind placed round the pupil, and perhaps of a radiated set also; they are considered voluntary in some animals, and may be so also to a certain extent in man.

3.—Adaptation of the Eye to see objects distinctly at different distances.

Ordinary focal length of the eye; its focus of parallel rays; range of general vision; range of distinct and minute vision.

Change by which the eye is adapted to see at different instances. 1st, Action of the iris: contraction of the pupil of the eye when directed to near objects; dilatation of the pupil of the eye when directed to distant objects; effect of these motions in modifying the quantity of light admitted, and in allowing or preventing the admission of the most divergent rays. 2d, Other changes in the eye-ball upon which its power of adaptation may depend: greater or less convexity of the cornea: compression of the eye affecting the length o. its axis or the distance between the cornea and retina: an alteration in the form or density of the lens; changes in the relative position of the transparent humours of the eye; observations of Porterfield, Young, and others.

Permanent varieties from the ordinary distance of distinct vision in different persons; near and long sight, myopia and presbyopia. General causes of these defects; manner in which they may be corrected by the aid of concave and convex lenses. Use of spectacles; of the telescope and microscope.

4.—Circumstances relating to Vision connected with the functions of the retina and sensibility of the optic nerves.

Law of vision, that a ray of light is seen only in a direction at right angles to the point of the retina on which it falls; experiments of Scheiner on visual direction. Useless attempts of physiologists to solve an imaginary difficulty in the fact that objects appear erect, though their images on the retina are inverted.

The part of the retina situated in the axis of the eye is endowed with a much greater sensibility to light than any other. Yellow spot and depression described by Soemmering at this part; nervous substance of the retina supposed by some to be wanting at the foramen centrale of the retina; this improbable. Cause of the indistinctness of lateral vision.

Extent of surface that can usually be seen by one or two eyes; extent of the visual angle horizontally and vertically; bounds by which it is circumscribed in the eye itself or in the orbit.

Absence of the power of vision at the part of the retina, corresponding to the place where the optic nerve passes through the sclerotic coat in the inner side of the axis of the eye-ball; simple experiments of Mariotte, shewing this spot; phenomena to which it occasionally gives rise.

The idea of an object presented to the mind by two eyes, of which the axes correspond, is single, although two nerves are simultaneously affected: explanation of this from the circumstance that the two images appear to be in the same position in space, when they fall upon corresponding parts of the retina in each eye. Nature of the commissure of the optic nerve; semi-decussation of the fibres of the nerves of the opposite sides. Observations of Wollaston on the occasional loss of sensibility to light of the retina on similar sides of the two eyes; observations shewing that this fact was known to Newton.

Circumstances occasionally giving rise to double vision. Immediate and remote causes of squinting.

5.—Ocular Spectra.

Duration of the impressions of light in general, for a short time after the luminous body or exciting cause is removed; illustrations of this. Impressions of light, when continued for some time, have the effect of diminishing the sensibility of that part of the retina on which they have acted. An increase of the sensibility of the whole, or of particular parts of the retina, is produced by the absence of light; experiments of Dufay and others. Simple ocular spectra produced by white light. Coloured spectra occasioned by the diminution of the sensibility of the retina to any of the coloured rays, and a proportional increase of its sensibility to the rest of the coloured rays required to compose white light; experiments.

Peculiarity of the vision of some persons in respect to the manner in which they are affected by certain colours; inability of some persons to distinguish certain colours; observations of Dalton, Nicholl, Herschel, and others.

Circumstances occasioning sensations of light in the eye, in the absence of any luminous body, as pressure on the eye-ball, galvanism, &c.

Spectral illusions connected with the condition of the eye; morbid increase or diminution of the sensibility of the retina.

Review of the structure of the eye and function of vision in different classes of animals.

6. Farther general Observations on the External Senses.

Supposition that some animals are endued with an external sense in addition to, and different from, touch, taste, smell, hearing, and vision. Experiments of Spallanzani and Jurine on the bat, from which it was concluded that this animal possessed a sixth sense, suited to the purpose of guiding it in its motions, and enabling it to avoid objects when its sight had been destroyed. Jacobson's opinion, that some animals have an organ of sense situated in the superior maxillary or incisory bone, which enables them to recognise those kinds of food which are best suited for their support. Tubular organ supposed to constitute a sixth sense in the ray tribe of fishes.

Hypothesis that the fifth pair of nerves supplies in some animals the place of special sensory nerves, as of the olfactory, auditory, or optic nerves. Erroneous conclusion from the supposed absence of the optic nerve in the mole, proteus, and some other animals; observations of Treviranus have shewn the optic nerve in the eye of the mole.

Supposed transference of the power of sensation from one nerve to another, and from the nerves of the organs of the external senses to those of the skin, in the state of natural and induced somnambulism; observations of Petetin, case of Miss Macavoy, and similar deceptions considered.

§ 50. Internal Sensations, Organic Sensations, or Sensations of Consciousness.

Nature of these feelings; circumstances in which they resemble or differ from the external sensations. Enumeration and description of the principal feelings of this kind.

Muscular feeling, or the sensation which informs us of the force, extent, and direction of muscular actions within us; some of the qualities of bodies examined by this sense; weight ascertained by its means. Sense of alacrity or lightness in the body may be considered as partly connected with the muscular sensation and partly independent of it, as may also the opposite feeling of lassitude or fatigue. Feeling leading to the exertion of the organs of sense or motion; opposite feeling giving a desire for repose.

Appetites. Hunger and thirst; their nature, seat, and causes; probably belong to the 8th pair of nerves. Sexual feeling.

Sensation giving a desire for the renewal of air within the chest and prompting to inspiration; another sensation belonging to the 8th pair of nerves; and one which continues to act perfectly during sleep. Sneezing, coughing, sighing, yawning.

Sensations prompting to evacuations; as of the bladder, rectum, or uterus, &c.

Sympathetic sensations, or phenomena of sensation proceeding from the connection of sensory nerves, and not immediately from an impression on the nerve in which the sensation occurs.

CHAP. III. MUSCULAR MOTION AND IRRITABILITY.

Functions connected with the contraction and relaxation of the Muscular or Irritable Fibre.

Arrangement of the subject. Difference in the nature of voluntary, involuntary, and semivoluntary muscles.

§ 51. Phenomena of Muscular Action.

1. Preliminary view of the structure of muscle.

Fasciculi of muscular fibres; cellular texture by which they are bound together; simple muscular fibres, their size and appearance in the microscope; ultimate filaments composing these fibres; views of Leeuwenhoek, Fontana, Prochaska, Home, M. Edwards, Hodgkin, and others; bloodvessels and nerves of muscle.

2. Change which the muscle undergoes during contraction.

General phenomena of muscular contraction, as the increased hardness and swelling of the body of the muscle, and wrinkled appearance of its surface. The volume of the muscle not changed during contraction; apparatus for shewing this; experiments of Glisson, Swammerdam, and G. Blane; its colour unchanged. Inquiry as to what change the individual fibres undergo when the ends of the muscle approach one another; are they simply shortened, or do they change their form or position? opinion of Prevost and Dumas that each fibre assumes a zig-zag position during contraction; doubt as to whether this occurs during the shortening or rather during the elongation which immediately follows it; observations of Verheyen and Hales.

Extent to which the shortening of muscular fibres can take place; difference in this respect according to the kind of muscle, and the distribution of its fibres; as in the voluntary and involuntary, circular and straight muscles.

3. Relaxation of Muscle.

Phenomena of this relaxation or elongation of the muscular fibres: this change cannot be a source of any new force in the body, further than that which may proceed from the constrained position into which the elastic cellular substance mixed with the muscular fibres has been drawn by the contraction.

4. Varieties of Muscular Action.

Tonic contraction differs from ordinary contraction of a muscle in the slowness with which the shortening takes place, and is succeeded by relaxation. Examples of tonic muscular contraction occurring in muscles during life, or after death in the voluntary and involuntary muscles, in the arteries, iris, &c. Experiment of Poiseuille to shew that the force of tonic contraction in the arteries after death is greater than that due to their elasticity, with which some have considered it as identical.

Ordinary condition of sphincter muscles.

Spasms of various kinds occurring in disease. Variety in the state of muscles occurring in catalepsy.

5. Conditions necessary to excite Muscles to contract.

§ 52. Property of Irritability inherent in Muscular Fibre.

Definition of this property according to the views of Haller. Tonicity, if to be regarded as different from irritability, may be considered as a modification of it.

Circumstances modifying the irritability of muscular fibres. Influence of heat or cold: difference of their effect according as they are slowly, or suddenly and violently applied. Influence of repetition; exhaustion of muscular force, fatigue: is the irritability of muscular fibre capable of being exhausted by frequently repeated stimulation; and if so, under what circumstances can it be regained? Influence of nutrition, or the supply of blood in the muscle; experiments by Edwards and Kay, shewing the effect of the circulation of venous blood in muscles on their action.

Duration of muscular irritability after death; difference in this respect in warm and cold blooded animals; experiments of various physiologists shewing the order in which different voluntary and involuntary muscles cease to be excitable after death; observations of Nysten on decapitated criminals.

§ 53. Nature of the Stimuli which excite Muscles to contract, and manner of their application.

Stimulus of the will, originating in the brain, and conveyed by certain nerves called motory to the voluntary muscles only.

Mechanical, electrical, and chemical stimuli; illustrations of their action; effect of the application of stimulant, sedative, and narcotic substances to muscles.

Inquiry whether a stimulus acts directly on the muscular fibre itself, or only through the nerves of a muscle; vis insita and vis nervea of muscles; controversy between Haller and Whytt regarding these powers. Argument attempted to be deduced from the manner in which some poisonous substances, especially narcotics, act on the system; experiments of Whytt, Monro, W. Philip, Morgan, Addison, C. Henry, and others. Attempts to prove that the involuntary muscles may be excited to contraction through their nerves; experiments of Whytt, Humboldt, Fowler, Brachet, and others.

§ 54. Conduction of Stimuli to Muscles by means of the Motory Nerves.

1. General phenomena of this conduction in all motory nerves.

Experiments proving the motory function of the anterior roots of the spinal nerves and of other nerves (see § 48, 3, *c*).

2. Functions of separate motory nerves.

Motory function of the third pair of nerves, or motores oculorum; experiments of Bell, Magendie, and Mayo. Ciliary nerves.

M. function of the fourth pair of nerves, or the pathetic nerve; its connection according to C. Bell, with the respiratory nerves, and with the actions of expression.

M. function of the smaller part of the fifth pair of nerves; observations of Palletta, and experiments of C. Bell, Mayo, and Bellingeri, shewing it to influence the motions of mastication.

M. function of the sixth pair of nerves, going to the external rectus muscle of the eye.

M. function of the portio dura of the seventh pair of nerves, or facial nerve; experiments of Bellingeri, C. Bell, Mayo, Magendie, Eschricht, and others, shewing it to be the nerve of voluntary motion in the face; Bellingeri's view that it also performs a sensory function; Bell's view of the association of this nerve, with other nerves going to the respiratory muscles, in motions of respiration and expression.

M. function of the glosso-pharyngeal nerve; reasons for believing this nerve to be a conductor of sensation as well as a nerve of motion.

M. Function of the spinal accessory nerve.

M. function of the pneumogastric nerve or parvagum; laryngeal nerves; their action in closing and opening the glottis. Pulmonary and gastric portions of this nerve; how far may they be regarded as exercising a motor function? experiments of Legallois, Broughton, Brachet, and others.

M. function of the hypoglossus, or 9th pair of nerves.

3. General remarks on associated and sympathetic motions, attributable to the connection of motory nerves.

In the voluntary muscles; in respiration; in expression of the passions; in physiognomy; in the different expulsions.

Connection of the motory nerves with instinctive motions.

4. Are the twigs of the Sympathetic Nerve endowed with any motory function?

§ 55. Effects of Muscular Contraction in producing motion. Mechanism of Animal Motions.

1. Application of the laws of Mechanics to Animal Motions. Animal Mechanics.

Circumstances in the form and structure of the bones, fitting them to serve as stable or moving supports to the muscles and the rest of the body; connection of the bones by joints, or soft intervening parts; synovial membranes; nature and uses of the ligaments. Attachment of the muscles to bones; tendons; bursae.

Different levers of the 1st, 2d, or 3d order formed by the bones, to which muscles are attached.

Circumstances in the attachment of muscles to bones which give rise to a considerable loss of the force generated by muscular action: as, 1st, the obliquity of the insertion of muscles into bones: or, 2d, of muscular fibres into a tendon; different kinds of muscles as straight, penniform, semipenniform, &c.; observations of Mayow, Monro, and others on the action of oblique muscles: and, 3d, the combination of several muscles acting in different directions to produce one motion. Circumstances in the construction of the body which seem to compensate for these disadvantages; large heads of most of the bones; eminences projecting from bones, as olecranon, sesamoid bones, patella, &c.;

pulleys diminishing the obliquity of insertion of muscles, &c. Great gain thus effected in the velocity and precision of the motions, while lightness, elegance, and symmetry are insured along with strength in the body by this mechanism of the moving powers and skeleton of animals.

2. Attitudes and Movements of Man and Animals.

Adaptation of the skeleton of man and animals to preserve stable position, and perform their necessary motions; erect position as peculiar to man among mammalia. Comparison of the skeletons of the vertebrated animals with one another, and with those hard parts of the avertebrated animals which serve the same purpose.

Station; centre of gravity of the body; carriage of the body; beauty of its positions and form. Balance; sea-sickness, and giddiness. Different attitudes of repose.

Progression or Locomotion of man and animals; walking, running, and leaping; trot, amble, and gallop of the horse. General resemblance among vertebrated animals in the manner in which progression is effected; differences in their structure suited to different kinds of progression. Motions of the anterior and posterior extremity.

Progression in water. Use of the swimming bladder of fishes. Other peculiarities in the structure of the organs of motion of aquatic animals.

Progression in air. Peculiarities in the construction of the organs of motion in birds, insects, &c.

Observations of Borelli, Perrault, Barthez, &c.

Muscular motions not connected with locomotion. Phenomena of effort or respiratory motions connected with the exertion of the voluntary muscles.

Force of muscular action. Calculations respecting the force capable of being exerted by single or combined muscles; comparative force of different muscles; computations of the force of the heart, &c.

Feats of muscular strength, to be distinguished from those of dexterity in which the muscles are not called into action. Instances of extraordinary strength in men; feats of Topham and Eckeberg. Strength of different nations of men and animals compared; observations of Regnier, Desaguilliers, Coulomb, Young, and others.

Circumstances tending to increase or diminish the actual force which muscles are capable of generating during contraction; training, gymnastics, &c.

§ 56. Nature and Mechanism of the Voice and Speech.

1. The Voice of Man and Animals.

Preliminary view of the structure of the human larynx, and other parts of the respiratory apparatus concerned in the production of voice; air-tubes, trachea; larynx, its cartilages, muscles, and nerves; vocal cords; os hyoides.

Qualities of the sounds of the human voice. Their tone, strength, and nature, as compared with the sounds of musical instruments.

Inquiry into the mode in which these sounds are produced. The lungs the bellows which give a stream of air varying in quantity and velocity. The windpipe, larnyx, fauces and mouth form a passage of variable tenseness, diameter and length which constitutes the tube of the vocal organ, and may be compared to the tube of a wind instrument. The vibration of the vocal cords of such a nature as to assimilate the vocal apparatus to the pipe of an organ more than any other musical instrument; observations and experiments of Ferrein, Dodart, Cuvier, Savart, Young, Biot, Magendie, Willis, and others.

Circumstances which appear to modify the tone of the voice. Manner in which the length, diameter, and tenseness of the parietes of the vocal passage may be altered. Use of the vocal cords; form of the aperture of the glottis, and cavity of the larynx during phonation; nature of the vibrations of the vocal cords; manner in which these vibrations may be made to vary by a change in the length, thickness, and tension of the vocal cords; important observations of Willis. Differences observable in animals, more especially in birds. Modulation of the voice in the back part of the throat: observations of Dzondi and Bennati; falsetto voice of singers.

Circumstances modifying the strength of the human voice; changes of the voice at different periods of life; in different sexes; remarkable provisions in some animals.

Difference between musical sounds of the voice, and ordinary sounds or noises; opinion of C. Bell that the thyroid gland acts as a damper.

2. Articulation of Voice. Mechanism of Speech.

Nature and classification of the conventional sounds employed in speech, or in different languages.

Description of the manner in which each of them is formed or modified by the throat, tongue, lips, and teeth.

Attempts to imitate by mechanical contrivances the voice of man and speech; by Vaucanson, Kratzenstein, Kempelen, and Willis.

Remarks on the art of the ventriloquist.

3. Pathological remarks on the Voice and Speech.

Different morbid affections influencing the voice and speech. Dumbness, &c.

Defects of speech from malformed organs, nervous affections or bad habits. Means adopted for the removal of these. Cultivation of the voice, and improvement of speech.

CHAP. IV. INFLUENCE OF THE CENTRAL PARTS OF THE NERVOUS SYSTEM ON THE ANIMAL AND ORGANIC FUNCTIONS.

Recapitulation of the functions of different nerves, preparatory to a general view of the functions of the brain, spinal marrow, and ganglia.

Method pursued in the investigation of this subject; difficult nature of the experiments required to be performed; their results as yet unsatisfactory; the necessity, in experimenting by the irritation or division of parts of the nervous system, of distinguishing, more accurately than has hitherto been done, between the loss of nervous influence itself, or of the power of its conduction only in the injured part.

Limitation of the present inquiry, and arrangement to be pursued in treating of it.

§ 57. Connection of the Cerebro-Spinal and Ganglionic Nervous Systems with Sensation and Motion.

1. Of the Spinal Cord and Medulla Oblongata as conductors of sensory impressions and of motory influence.

a. The spinal marrow ; structure of its columns, and relation to these of the roots of the nerves proceeding from the spinal chord.

Does the spinal marrow consist merely of the united fibres of the spinal nerves, or are these combined in it with fibres of another kind ? Do the fibres of the roots of the spinal nerves or of the spinal marrow itself continue separate from one another in the whole length of the spinal marrow ? Researches of Gall, Bell, Rolando, and Bellingeri.

Relation of experiments, shewing that volition and other stimuli are conducted downwards towards the roots of motory nerves, principally, if not solely, by the anterior columns of the spinal cord, while the impressions of sensation are transmitted from the roots of the sensory nerves upwards to the brain, principally, if not solely, by the posterior columns. First experiment of Magendie in proof of this ; confirmatory experiments of Beclard, Flourens, Amussat ; late and accurate experiments of Backer, J. Müller, and Seubert. The results of these experiments not as yet satisfactory.

Experiments of J. Müller, shewing that a mechanical or galvanic stimulus may be conducted either upwards or downwards by the spinal cord, so that irritation of either the upper or lower part may produce contractions of the muscles, deriving their nerves from the opposite extremities of the cord respectively.

Experiments seeming to prove that both columns to a certain degree conduct impressions of sensation and motory influence ; of Schoeps, Fodéra, Rolando, and Bellingeri ; opinion of Bellingeri that contractions of the extensor muscles are excited through the posterior, those of the flexor muscles through the anterior columns of the spinal cord, and that while the spincters are relaxed through the posterior they are contracted through the anterior columns ; objections to these views.

Speculations respecting the difference in the properties of the white and grey matter, and of the central and superficial part of the spinal cord. Opinion of Bellingeri that sensation belongs to the grey substance, motion to the white substance of the spinal marrow ; observations opposing this view.

b. The medulla oblongata. Observations of Burdach, Rolando, Bell, Rosenthal, and others, on its structure.

The experiments on the functions of this part not so conclusive as those on the spinal cord. The medulla oblongata less purely a conductor and more distinctly a source of nervous influence than the spinal marrow. Experiments, taken along with the analogy of structure and the similar origin of nerves from both, seem to prove that the conducting function of the anterior and posterior parts of the medulla oblongata, corresponds very much with that of the similar columns of the spinal cord ; in some experiments, however, pain and muscular contractions have proceeded from the irritation of either of the columns of the medulla oblongata ; experiments of Flourens and Hertwig. How does the decussation of the pyramidal columns affect this ? In most of the experiments the injury of one lateral half of the medulla oblongata has occasioned palsy on the same side.

2. Of the Spinal Cord and Medulla Oblongata as the sources of motory influence, or the seats of sensation, independently of the brain.

Earlier experiments of Legallois and others, shewing the continuance of the motions of respiration, after the medulla oblongata has been separated from the brain ; other motions observed to go on under the same circumstances.

Recent experiments of Mayo on the rabbit, and of Marshall Hall on the turtle, frog, and newt, shewing that after the medulla oblongata or the spinal cord have been entirely separated from the brain, these animals have appeared still to be possessed of some power of voluntary motion and sensation in the parts deriving their nerves from the isolated spinal cord, or even from only a part of it. Farther illustration of these phenomena by the experiment of inducing the narcotised state in animals by means of opium or strychnine. Views of Marshall Hall on the reflex function of the medulla oblongata and spinal cord. How far are the phenomena on which these views are founded analogous to those of nervous sympathy ?

The medulla oblongata probably the seat of some sensations ; connection of all the sensory nerves, excepting the olfactory and optic nerves, with this part of the brain.

It is obviously the source of a nervous influence giving rise to many involuntary, and perhaps to some voluntary motions, at least in cold-blooded animals.

Its influence on the motions of respiration (see § 58, 2.)

3. Connection of the Brain with Sensation and Motion.

Preliminary anatomical description of the structure of the brain ; the connection of its parts ; course of its fibres ; connection of the sensory and motory roots of the compound nerves, of the simple cerebral nerves, and of the columns of the medulla oblongata and spinal marrow, with the parts of the brain.

Introductory remarks on the functions of the brain in general ; limitation of the present inquiry.

A. Circumstances connected with the condition of the brain which influence its functions.

Influence exerted by the circulation of the blood in the brain on its functions. Peculiarity in the mode of circulation of blood in the brain, depending on the closed condition and inflexible nature of the parietes of the skull ; observations and experiments of Haller, Kellie, &c.

Effects of a vitiated condition of the blood circulating in the brain ; experiments on the effect of the injection of venous blood into the cerebral arteries. State of the brain in those affected with cholera ; remarkable effects of the injection of water into the blood-vessels in them ; similar experiments on dogs affected with hydrophobia. Ought the insensibility or loss of voluntary power in asphyxia to be attributed most to the altered condition, or to the diminished quantity and force of the blood circulating in the brain : state approaching to asphyxia, induced by excessive intoxication.

Alternate elevation and depression of the brain, seen at the fontinelles in the infant's head, or in that of an adult person when a portion of the skull has been removed, occasioned by the retardation of the flow of blood in the veins during expiration, and its acceleration during inspiration.

Pulsation of the brain occasioned by the impulse of the blood in its arteries.

Fluid contained in the ventricles of the brain; its supposed uses; Magendie's experiments on the effects of its being made to accumulate or allowed to escape.

B. Account of the experiments and observations which have been made with a view to investigate the connection of the brain with sensation and motion, by the destruction or injury of its different parts; chiefly by Haller, Zinn, Lorry, Saucerotte, Rolando, Flourens, Magendie, Serres, Fodéra, Hertwig, and Bouillaud.

a. Effect of injuries of the whole brain or encephalon on the functions of sensation and motion.

Pressure on the brain is obviously injurious only when it extends to the parts at its base giving origin to the nerves, or to the medulla oblongata and spinal cord; difference in the effect of lateral compression and vertical pressure of the brain; pressure from morbid effusions; apoplexy. Inflammation; nature of what is called determination of blood to the head and brain; how far may the circulation of blood in the brain, or the functions of that organ, be supposed to be influenced by an alteration in the force of the heart, or of the blood in the bloodvessels? To what is the loss of consciousness in syncope to be attributed? Great difficulty of being assured that the real or sole effect of the injury by compression is at the place at which it has been applied.

Effect of violent concussion of the brain; supposed nature of the injury to the brain in this affection.

Injuries of the surface of the cerebrum or cerebellum are not in general attended with pain or convulsions; the same the case in injuries extending to a small depth only from the surface; no apparent difference of effect from the destruction of the white or of the grey substance of the convolutions. Alleged different effect of the irritation of the membranes covering the brain and of its substance; observations of Serres and others.

b. Effect of deep-seated injuries of the cerebrum upon sensation and motion.

General law that an injury of the brain on one side is followed by loss of sensation and motion in parts of the body on the opposite side. Difference in the occurrence of this phenomenon in the parts deriving their nerves from the spinal marrow and in those supplied with nerves from the brain; the crossing of the effect almost always occurs in the first; while in the second, the loss of power is as often on the side of the injury as on the opposite one. Relation of the optic nerves and thalami optici to these phenomena. When convulsions accompany palsy from an injury of the brain, the convulsions are in general on the same side as the injury of the brain. How far may this phenomenon be explained by the decussation or passage from one side to another of the fibres of the brain, medulla oblongata, or spinal cord?

Opinions regarding the functions of the commissures of the brain.

Importance of attention to the origin of the nerves, and their course within the brain, in these experiments, and of distinguishing between the simple power of conduction of nervous influence by tracts of cerebral substance, (such as the power of conduction residing in the columns of the spinal cord), and the generation of nervous influence in the part of the brain operated on.

Account of the experiments of Rolando, Flourens, Magendie, Fodéra, Hertwig, and Bouillaud on the substance of the cerebral lobes, the corpora striata, thalami optici, corpora quadrigemina, pons varolii, and crura cerebri; great discrepancies in the results.

Pathological observations of Serres, Saucerotte, Foville, Grandchamp, Cruveilhier, and others.

General results of these experiments and observations. Sensation and motion do not exclusively belong to any one of the above mentioned parts, but depend on the integrity of the whole. They are principally affected by injuries of the parts near the base of the brain, as the corpora striata, thalami optici, corpora quadrigemina, peduncles of the brain, &c.

c. Effects of deep-seated injuries of the cerebellum on sensation and motion.

Remarkable experiments of Rolando, Magendie, Flourens, and Hertwig, proving an intimate relation between the integrity of the crura of the cerebellum and voluntary motions; theory that the cerebellum is the regulator of voluntary motions considered.

Connection of the cerebellum with sensation, which had been presumed to exist from the position of the cerebellum, and its union with the posterior columns of the spinal cord, not proved by observation or experiment.

Effects of injury of the pons varolii.

4. Connection of the ganglia of the sympathetic system of nerves with sensation and motion.

Structure of the ganglia and nerves of the great sympathetic.

Experiments of Bichat, Wutzer, Flourens, Brachet, and J. Müller.

Remarks on the nature of the nervous influence supposed to originate within, and to proceed from, the ganglionic or sympathetic system of nerves in reference to the subject of the next section. More intimate connection of this system with the organic than with the animal functions of the economy: uses of the ganglia in general; views of Johnstone, Bichat, Lobstein, Wutzer, Brachet, and others.

§ 58. Influence of the Cerebro-Spinal and Ganglionic Nervous Systems on the Nutritive Functions.

Remarks on the influence of the nervous system on the Organic Functions in general.

1. Influence of the Cerebro-Spinal and Ganglionic Nervous Systems on the Functions of Circulation.

a. On the Action of the Heart.

Anatomical description of the nerves of the heart.

Involuntary nature of the heart's action.

The heart may be stimulated by the application of heat or cold, chemical or galvanic irritations to its surfaces; apparent difference in the outer and inner surfaces of the heart in this respect. In what manner does the blood act as a stimulus to the heart's action?

The action of the heart continues after its nerves have been divided. Attempts of physiologists to excite the action of the heart by the stimulation of the trunks of its nerves: experiments of Humboldt, Fowler, Brachet, Burdach, not satisfactory; experiments of Bartels on the bodies of decapitated criminals; remarkable experiment of Brachet, in which he affirms that the action of the heart immediately ceases when the cardiac ganglion is destroyed: objections to which such experiments are liable.

The rythmic action of the heart, especially in cold-blooded animals, continues for some time after the organ is removed from the body. In this instance, as also when the nerves of the heart have been divided, is the action of the organ kept up through the influence of the nerves left connected with it, or by a property of the muscular fibres themselves?

Undoubted direct influence of passions of the mind, and some nervous affections, as smell, &c. on the heart's action. Alleged instances of persons possessing a voluntary power over the motions of the heart: Colonel Townsend's case. By what means may this kind of influence be conveyed to the heart?

Effect of injuries of the brain and spinal marrow on the heart's action; effect of mechanical irritation, concussion, compression of the brain, &c. Diminution of the force generally, and total cessation of the heart's action occasionally produced by sudden and violent destruction of the brain or spinal marrow; experiments of Legallois, Brodie, Wilson Philip, and others; effects of the application of irritating or sedative substances to the brain and spinal marrow; fallacies to which such experiments are liable.

State of the heart and organs of circulation in some anencephalous fœtuses.

Conclusion from the above mentioned experiments, and from the observations of Treviranus, Nasse, Wedemeyer, Flourens, Marshall Hall, and others, that the heart's action, though not immediately dependent upon, is yet considerably influenced by the brain and spinal marrow.

b. On the Motion of the Blood in the Bloodvessels.

Branches of the sympathetic nerves which everywhere accompany the bloodvessels.

Instances in which the circulation is obviously changed in the small vessels through nervous influence; blushing and paleness from passions of the mind; erection, &c.

Effects of the division of the nerves of a limb upon the circulation, as observed in experiments on animals by Treviranus, Baumgaertner, and others; languid state of the circulation in palsied limbs. Observations of Haller.

c. On the Nutrition of the Textures.

Atrophy of palsied limbs, and their liability to be affected with some morbid degenerations. Experiments of Magendie and others on the inflammation, opacity, ulceration and other effects induced in the eye by division of the fifth pair of nerves: experiments of Dupuy and Mayer shewing similar results from the injury of the sympathetic nerves.

Alleged retardation of the healing of wounds after division of the nerves, by Nasse, Baumgaertner, and S. Van der Kolk. The reproduction of lost parts said not to occur (in those animals in which it naturally takes place) after the complete division of the nerves.

Instances in which the absence of an organ of the fœtus has been found to be attended with the want of its nerves; examples of an opposite kind, as in the origin and formation of the parts of the embryo, apparently independent of any nervous influence; and in the full development of the bodies of acephalous or anencephalous fœtuses.

d. On the Secretion of Fluids.

Nerves of the glands and other secretory organs.

Effect of mental emotion on the quantity and qualities of various secretions, as tears, bile, urine, milk, cutaneous perspiration, discharge from wounds.

Sympathetic affections of the secretory organs supposed to be explicable from the connections of their nerves; as the flow of saliva from the presence of food in the mouth or stomach, or certain sounds, of tears from pungent substances in the nose, &c.

Experiments shewing an increase of the secreted fluids from the direct stimulation of the secreting organs; Humboldt and Most.

Experiments shewing that the quantity of fluid secreted by any organ is at one time diminished, at another increased, and that the quantity of the peculiar ingredients of the fluid is in general diminished, and its composition altered, by the division of the nerves of the secreting organ; of Legallois on the lungs; of Brodie, Krimer, Brachet, and others on the kidneys, 1st, From destruction of the spinal marrow; 2d, From division of the renal nerves; 3d, From division of the sympathetic nerves in the neck: re-establishment of the natural secretion of urine by the galvanic stimulation of the renal nerves.

Influence of the cerebro-spinal and other nerves on the evacuation of the urine and other secreted or excreted products.

2. On Respiration.

a. On the motions of Inspiration and Expiration.

Nerves of the respiratory organs.

The pneumogastric nerve, the nerve of sensation of the air-passages and lungs; experiments of Krimer and Brachet on the irritation of the air-passages after division of this nerve.

Cause of the regular succession of the motions of inspiration and expiration: it is not to be attributed to the sensation conveyed by the eighth pair from the air-cells of the lungs to the medulla oblongata, for otherwise all respiratory motions would immediately cease upon the division of the nerve, which is not the case. The influence necessary for the continuance of the respiratory motions is derived from the medulla oblongata, after the division of which below the origin of the eighth pair, the motions of respiration immediately cease. These motions do not depend on an influence derived from the brain.

Effect of division of the spinal marrow at different parts, above or below the origin of the phrenic nerves; experiments of Legallois, Brodie, Flourens, and others.

b. Cause of the gradual Asphyxia and Death which follow the division of the Eighth Pair of Nerves.

Effects of this operation, 1st, On the opening and closing of the glottis; variety in different animals and at different ages in respect to the time at which death occurs, from the affection of the glottis following this operation; experiments of Legallois. 2d, On the voice. 3d, On the power of motion in the muscular fibres of the air-tubes. 4th, On the chemical process of arterialization of the blood. 5th, On the secretions within the air-tubes and cells, and their removal. 6th, On the state of the blood in the vessels. Experiments of Legallois, Dupuytren, Dupuy, Emmert, Provençal, Brachet, Mayer, and others.

Effects of the division of the sympathetic nerve on respiration.

c. Association of the Respiratory Motions.

Examples of the associated motions of the respiratory muscles, in ordinary and in forced states: motions of the muscles of the face connected with respiration and expression. Influence of the portio dura and other nerves on these motions; connection of the respiratory nerves: remarks on the irregular or respiratory system of nerves of Bell.

3. On the production of Animal Heat.

Observations of Earle and others on the low temperature of palsied limbs in man; experiments of Elliot, Home, and others, on the effect of division of the nerves of the limbs of animals on their heat.

Experiments of Brodie, from which he concluded that the brain and spinal marrow are the source of animal temperature; contrary experiments of Legallois.

Experiments of Chaussat and others on the influence of the sympathetic nerves on the maintenance of animal temperature.

Conclusion, that animal temperature is influenced by the nervous system mediately only, or principally through the organs of respiration and nutrition.

4. On Digestion, &c.

Nerves of the stomach and intestines.

The sensations of the œsophagus and stomach depend upon the 8th pair of nerves: hunger and thirst, satiety.

Influence of this nerve on the motions of the stomach and œsophagus; action of emetics, vomiting.

Experiments of Wilson Philip, Breschet and Milne Edwards, Tiedemann and Gmelin, Leuret and Lassaigne, shewing that the process of digestion is impaired by the division of the 8th pair of nerves. Is this to be attributed to a palsy of the muscular coat of the stomach, to a change in the secretions of the stomach, or to a general constitutional affection.

Effect of the division of the 8th pair of nerves on the action of poisons taken into the stomach.

Examples of the influence of the brain, mental emotions, &c. on the functions of the stomach; and of the stomach and digestive organs on the functions of the brain; intoxication, &c.

Effects of irritation or division of the ganglia and nerves of the sympathetic system of nerves on the motions and functions of the intestines.

§ 59. Influence of the Cerebro-Spinal and Ganglionic Nervous Systems on the Reproductive Functions.

1. On the Reproductive Functions belonging to the Adult.

The sensations of the reproductive organs belong chiefly to the cerebro-spinal nerves. The process of parturition is subjected to the influence of the same nerves; experiments and observations of Brachet.

The secretion and evacuation of the seminal fluid in the male, and conception in the female, are independent of the cerebro spinal, but influenced by the sympathetic nerves.

Influence of mental emotions and cerebral affections on the reproductive functions. Intimate connection supposed by Gall to subsist between the state of the sexual feelings and the cerebellum. Arguments for and against this view deduced from observations in pathology by Gall, Serres, Burdach, Hennen, Larrey, Cruveilher, A. Combe, and others; from direct experiments on the effect of the injury of the cerebellum in animals; from varieties in the structure of the cerebellum in animals.

Connection of the spinal marrow with affections of the reproductive organs. Nervous sympathetic affections occurring during pregnancy.

2. On the development of the Young.

Influence of the nervous system of the parent on the impregnation of the ova; effect of galvanizing the ova.

Supposed influence of the nervous system and of passions of the mind of the parent on the formation and development of the embryo; nervous connection of the parent and fœtus.

Supposed dependence of the origin and development of the organs of the fœtus on the formation and influence of the nervous system of the embryo itself.

§ 60. Nature of Nervous Influence or Power.

1. History of opinions regarding Nervous Influence. Reasons for regarding this influence as a distinct vital power; its nature equally unknown to us with that of the properties of sensibility and irritability. Views of Cullen.

2. Supposed analogy of nervous influence and the electrical or galvanic agent. History of the origin of this theory; its improbable nature; experiments of Galvani, Humboldt, Volta, Monro, and others; more modern attempts to prove that the galvanic agent may be substituted for nervous influence in some of the processes of the economy; experiments of W. Philip on digestion; of Krimer, Weinhold, and others, on other functions; remarks on the fallacy of the conclusions drawn from these experiments; comparison of the general laws of the operation of the nervous power with those of the galvanic agent.

3. Attempts of some physiologists to shew that electricity or galvanism is evolved during the ordinary processes of the animal economy; observations of Pfaff, Ahrens, and Meissner, Pouillet, Bellingeri, and Dutrotchet, on the processes of the organic functions; attempts of Humboldt, Prevost and Dumas, Edwards and others, to shew that a current of electricity frequently flows along the trunks of the nerves, more especially those distributed to the muscles; contrary experiments of Person, Müller, &c.

4. On the nature of the agent causing the shock, and other phenomena produced by the fishes called Electrical: Is a similar power possessed by any other animals? Structure of the electrical organs in the torpedo, gymnotus, and silurus. Observations and experiments of Welsh, Spallanzani, Humboldt and others; late experiments of John Davy, proving the great similarity between the agent producing the shock and galvanism.

Influence of the nervous system of the electrical fishes on the production of the shock.

5. Uses of electricity and galvanism in medicine.

CHAP. V. MENTAL FACULTIES OF MAN AND ANIMALS.

§ 61. Intellectual and Moral Faculties of Man.

Nature of mental phenomena as distinguished from those of the material world; and means of becoming acquainted with them.

Consciousness; sensation and perception; simple and compound ideas; attention; abstraction; association; imagination; memory; judgment; comparison; reflection: volition or will; emotions and passions, joy, sorrow, hope, fear, anger, &c.; desires and appetites; moral sense; observation; laws of belief; experience.

Various states of the mind in different individuals, ages, conditions of the body, &c.

Mental derangement, delirium, mania, monomania, idiocy.

§ 62. Connection of the Mind with the Body, especially with the Brain.

Proofs that the brain is the organ of the body with which the mind is more immediately connected in our present state of existence; from the effects of disease and injuries of the brain; from experiments on animals, as in those of Rolando, Flourens, Hertwig, Bouillaud, and others.

Attempts to shew that particular faculties of the mind belong to particular regions or parts of the brain. History of opinions relating to this subject.

Theory of Gall or Phrenology. Facts and observations of a physiological and a pathological kind on which the phrenological system is founded. Cranioscopy. Objections to this system of mental physiology.

§ 63. Comparison of the Intellectual Faculties of Man and Animals.

Proofs of the existence of sensation and volition in all animals properly so called, with which we are acquainted; consciousness or mind in the simplest kinds of animals.

Instinct: definition and description of this power; examples of instinctive actions in animals and man. Are instinctive motions voluntary or not?

Evidences of the exercise by brutes of other mental faculties; memory; association; some reasoning power and invention. Emotions and passions. Absence of cultivated reason, experience, language, use of the hand, &c. as distinguishing animals from man.

Phrenology and cranioscopy applied to animals; observations of Vimont and others on the comparative size and varieties of form of the brain in man and the higher animals.

DIV. IV.—SUBJECTS NOT COMPREHENDED IN THE THREE FOREGOING DIVISIONS.

§ 64. NATURAL HISTORY OF MAN. Varieties of the Human Species.

Preliminary remarks on the scale of animal being; the arrangement and classification of animals; differences among them which constitute generic and specific distinctions.

Geographical distribution of man and animals; circumstances influencing the spreading of races, their acclimatization, &c.

Differences among men in respect to their physical conformation; colour of the skin; form of the skull; of the skeleton in general.

Differences among men in respect to the performance of the various functions; their liability to diseases, &c.

Differences in the intellectual powers, original or acquired, among various races of men; influence of civilization, national character, situation, the state of society, &c. on these.

Description of the various nations and tribes of men belonging to the Caucasian, Mongolian, Ethiopian, American, and Malay races; researches of Blumenbach, Cuvier, Lawrence, Pritchard, Virey, Bory de St Vincent, Desmoulins, and others.

Comparison of the physical conformation of man with that of those Apes which resemble him most nearly.

§ 65. Modification which the Functions undergo in SLEEP and allied states.

Definition of sleep; description of its phenomena. The animal functions principally affected in sleep. The mind not altogether inactive; sensations which are felt, and voluntary motions executed.

The organic functions little changed. Circulation and respiration somewhat slower than in the waking condition; animal heat diminished.

Causes of sleep; mental and corporeal; its periodical return; duration at different ages, and in different individuals, &c. Sleep of animals and plants; state of the functions in hybernating animals.

Reverie and dreaming. Night-mare or incubus. Physical and mental causes of these states.

Trance. Cataleptic state. Stupor, sopor, and coma.

Somnambulism: supposed state of sensation and volition in this condition; sleep-walking; other phenomena. Natural and artificial somnambulism; animal magnetism: clair-voyance; supposed transference of special senses from their appropriate organs to other parts of the body. In the state induced by the operations of animal magnetism, is it entirely through the mind or imagination of the person magnetized that the effects are primarily produced, or is there any appreciable bodily affection ?

Spectral illusions; illusions of the organ of sense depending on mental affections only; those depending on a local affection of the organ of sense.

66. Modification which the Functions undergo from Age, Constitution, Temperament, Habit, Custom, &c.

§ 67. DEATH.

1. Natural decay and dissolution of the system in old age.

Circumstances in the physical construction and in the functions of the body which bring about natural decay of the system; alterations in structure and functions which the body undergoes in old age; decay of the animal and organic functions.

Ordinary duration of life; instances of extreme old age; effect of climate, mode of life and other circumstances on this.

Proportion of deaths in old age to those at earlier periods of life; liability of different ages, sexes, &c. to diseases which shorten life; influence of employment, trades, professions, &c. on health, and the duration of life.

2. Sudden or violent death, and death from disease.

Real and apparent death distinguished from one another. Phenomena of real and complete death, or the permanent extinction of the animal and organic functions. States resembling death; insensibility and loss of voluntary power, in fainting, asphyxia, coma, &c,

Various kinds of death. Views of Bichat. 1. Death arising from an affection of the organs of circulation; 2. from that of the respiratory organs; 3. from that of the nervous system acting on either of the above mentioned vital functions.

§ 68. Action of Poisons on the System *.

Different kinds of poisons arranged according to the most prominent phenomena of their action on the animal economy. Irritant, narcotic, and narcotico-acrid poisons; differences among poisons in respect to the class of functions which they affect primarily or secondarily.

Must all poisons be absorbed into the circulatory system before they produce their deleterious effects, or can any act directly or by sympathy on the nervous extremities? Observations of Orfila, Christison, Brodie, Magendie, Segalas, Emmert, Vernière, Morgan and Addison, and others.

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* In the table page 5, this article has been misplaced before that on Death.